The AMSAT Journal

Incorporating the AMSAT Newsletter
Volume 13 No. 1 March 1990

Editor: **Joe Kasser, G3ZCZ**
Managing Editor: **Robert M. Myers, W1XT**

Six for the Price of One, or OSCAR Count Reaches 19

On 22 January 1990 OSCARs 14, 15, 16, 17, 18 and 19 were placed into orbit from an Ariane launch vehicle. This article is a diary of those hectic days before and after the launch.

By the AMSAT team.

October 13, 1989 Situation Report

Two weeks ago, Arianespace postponed the launch of the rocket which is to carry SPOT-2, UoSATs-D and E and the four MicroSats into orbit. Early this week, the UoSAT and AMSAT teams were formally notified that the new launch date is 19 January 1990; the launch campaign will start some six weeks earlier, at the end of November.

Announcement of the launch delay came nearly "too late" for both the AMSAT and UoSAT teams. AMSAT's test gear was already at the Ariane launch complex in Kourou, French Guiana, and the launch team was due to fly south within 12 hours of the announcement! In England, UoSATs-D and E had been out of the thermal-vacuum chamber for three days, during which both satellites had been destacked, checked, restacked and taken to Portsmouth for spin balance testing. Final vibration tests were scheduled for Friday, and shipping to Kourou was set for Monday. Travel and shipping plans were immediately frozen as the news came in on Thursday night (28 September).

The launch delay will allow for more thorough and leisurely testing of the spacecraft. This began on 29 September when engineers from the European Space Agency Technical Center (ESTEC) came to perform final check-out of the Transputer Data Processing Experiment (TDPE) and its interface to the UoSAT-E CCD camera. These tests demonstrated the potential complexity and flexibility of the UoSAT-D/E onboard data handling system.

Groundstation software was used to load TDPE programs as "files" to the standard UoSAT FORTH DIARY running on the 1802 On-Board Computer (OBC). The OBC then loaded these programs to the TDPE using the Transputers' built-in serial bootloaders and the UoSAT Data Sharing (DASH) bus. The TDPE then commanded the CCD camera to take a picture, the picture was transferred from the camera to the TDPE at 5 Megabit/Second, and finally the TDPE downloaded the image at 9600 bps to the "groundstation" using a simple asynchronous packet format. The Transputers are programmed in OCCAM; the 1802 in FORTH; and the groundstations in C! After these tests, UoSAT and ESTEC engineers gave both the CCD camera and the TDPE clean bills of health.

The optics and the electronics of the UoSAT-E CCD camera were designed by engineers at UoSAT. The design is expected to provide Earth imaging with a resolution of approximately 10 kilometers

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Fuji-OSCAR-20 in Orbit and Working

On the 7th of February 1990, Fuji-2 or Fuji-OSCAR-20 lifted off from the Tanegashima Space Center of the National Space Development Agency of Japan (NASDA), together with the Marine Observation Satellite 1b (MOS-1b) the primary payload and the Deployable Boom and Umbrella Test (DEBUT) payload which is similar to JAS-1b in shape and weight.

Separation of DEBUT and JAS-1b from the launch vehicle took place at 0233 above Santiago, Chile, after the boosting up of the orbit following the ejection of MOS-1b into a polar circular orbit. First signal reception of Fuji-2 in Tokyo was at around 0309 UTC.

Fuji-2 is similar to Fuji-1 (Fuji-OSCAR-12) and you can hear the CW beacon signal with telemetry on 435.795 MHz with a Doppler shift of up to 9 kHz. Both transponders have been in operation and a number of QSOs have been reported.

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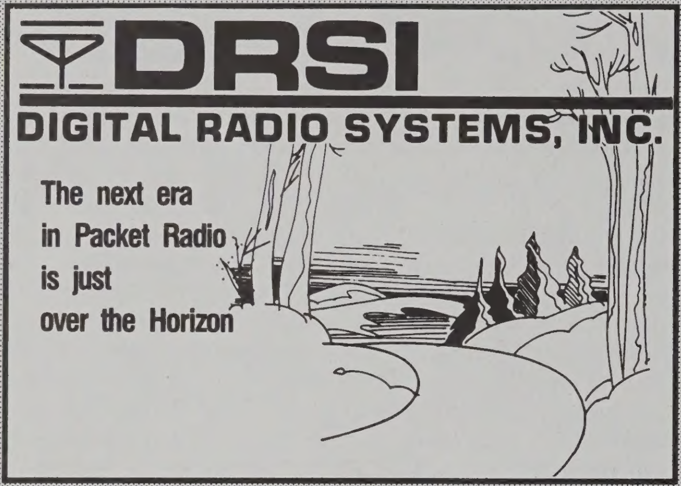

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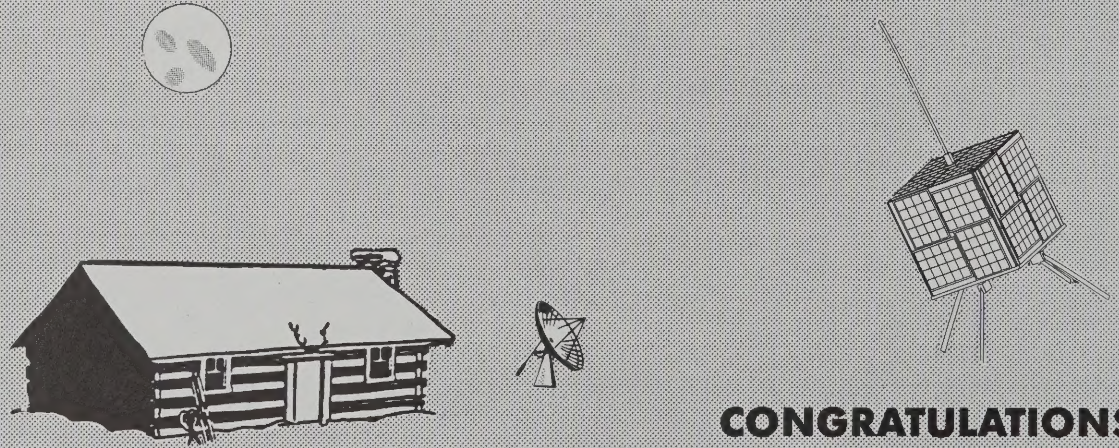
WE'RE ABOUT TO DO IT AGAIN



CONGRATULATIONS, AMSAT ON A GREAT LAUNCH!

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The President's Editorial

By Doug Loughmiller, KO5I
President, AMSAT-NA

If there is one common trait shared by each and every AMSAT member it is the desire to gain meaningful information. Over the years the leaders of the organization have grappled with how to best serve this universal need, particularly with respect to our publications. To say the least, there are no easy answers when it comes to the question of how to best serve the membership with a regular publication. This is true because of a number of different factors which must be considered when one approaches this issue.

The first factor which must be considered is the manner in which AMSAT produces its publications. As is the case with all AMSAT endeavors, the editorial process of producing a publication is dependent upon a small volunteer staff. A common misconception is the one that AMSAT has a large office full of paid personnel who devote full-time to producing our publication. Not only is this not the case, but in addition, AMSAT does not compensate authors for their submissions. Here again, when material is submitted for publication, all of the time and effort in putting the article together is, in effect, donated to AMSAT. As a result our members benefit by having access to the information contained within the given article.

The second factor which must be taken into consideration is the content and availability of information to be conveyed to the readership. The challenge of putting useful and worthwhile information into the hands of our members whose specific interests and levels of expertise vary greatly is immense. The concept of meaningful information varies from person to person. However, the information to be conveyed can be broken down into three basic areas.

The first area is the purely technical information. This material includes theoretical information about spacecraft design and fabrication which represents information about the leading edge technical activities within the organization. Obvious-

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TWO HAM-IN-SPACE SHUTTLE MISSIONS COMING UP

By Tom Clark, W3IWI, Ron Parise, WA4SIR, and Bill Tynan, W3XO

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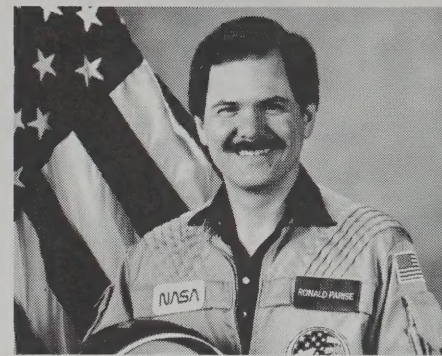

Astronaut Ron Parise, WA4SIR.

Background

Many will remember the excitement that prevailed when Owen Garriott, W5LFL, became the first "ham in space" during the STS-9 flight of Columbia back in 1983. This was followed two years later by another Amateur operation during Mission STS-51F by Tony England, WØORE. While W5LFL's operation was limited to voice using 2 Meter FM, WØORE was able to add two-way Slow Scan TV. This was permitted by a greatly expanded Amateur communication package dubbed SAREX for Shuttle Amateur Radio Experiment. The "experiment" designation has been instrumental in opening many doors to future Amateur Radio participation in U.S. manned space missions. Proposals for the inclusion of Amateur Radio on both of these flights were prepared and submitted to NASA jointly by AMSAT-NA and the ARRL. Acceptance of these proposals came as a particular pleasure, in the light of previous unsuccessful attempts to have W5LFL operate an Amateur station from Skylab.

When Ron Parise, WA4SIR, an active AMSAT member, was selected as a Payload Specialist to operate the Astro 1 Payload on a mission then scheduled for early 1986; thoughts immediately turned to capitalizing on another ham-in-space opportunity. By this time, packet radio had taken a firm hold in Amateur Radio and, naturally, proposals were advanced to include that mode in any Shuttle flight for which NASA authorization might be obtained. Ron was especially anxious to include packet on his flight as he is a devotee of that mode.

While the packet hardware and software gurus charged ahead, the proposal writers got to work and, once again a joint proposal was submitted. Informal word was received that this proposal was all but approved. But, everything came to a screeching halt when the Challenger disaster struck. The Astro 1 Mission was scheduled for the flight following Challenger. Plans did not begin again in earnest until mid-1987. By that time the ARRL Board of Directors, recognizing continued Amateur participation in manned space flight as an important ingredient in promoting Amateur Radio and helping instill an interest in technological pursuits by young people, established a committee to promote Amateur operation from as many future U.S. manned missions as possible. This group, which became known as the SAREX Committee, was also charged with finding ways to take maximum advantage of such ham-in-space opportunities which might be approved by NASA. ARRL President, Larry Price, W4RA, appointed Roy Neal, K6DUE, as Chairman. The initial ARRL Headquarters representative was Jon Bloom, KE3Z. Rosalie White, WA1STO, has since been appointed replacing Jon. Lou McFadin, W5DID, of the Johnson Space Center (JSC) Amateur Radio Club (JSCARC) was appointed to represent that group which had been so instrumental in preparing and testing hardware for the two previous flights. Bill Tynan, W3XO, was asked to represent AMSAT and coordinate its participation in the effort.

Work Begins Anew

At the SAREX Committee's first meeting, it was learned that, despite ARRL's and AMSAT's best efforts prior to the Challenger accident, SAREX was not included among the planned experiments on the new Astro 1 flight, designated STS-35. More joint efforts in the form of letters to NASA Headquarters were needed to correct this situation. But Headquarters approval, as important as it is, is not the end of the line. Any proposed Shuttle experiment must be thoroughly documented in an Interface Control Document (ICD). It must be subjected to numerous rigorous safety analyses and tests. Space must be found aboard the orbiter to safely stow it during assent and landing. The safety aspect of getting final approval for carrying anything aboard the Shuttle cannot be over emphasized. Not surprisingly, safety considerations have taken on an even greater emphasis since the Challenger disaster.

Of great help in seeing to it that all the required paperwork, including ICDs, annexes thereto, safety analyses and a myriad of other reports and documents were properly completed on time was John Nickel, WD5EEV. John volunteered for this thankless task, and was duly appointed by Dave Sumner of ARRL, to represent the SAREX Committee in Houston and "get the job done". It must be said that John has done an excellent job. Aiding him in his task has been the tremendous cooperation of many people at JSC, most of them not hams, who have helped prepare and review the large stack of papers needed.

Safe stowage space during assent and landing was mentioned as a matter of primary importance. Experiments such as SAREX are stored in lockers on the orbiter's mid-deck. In the two years since Challenger, various proposals were advanced to again include SSTV and to add a Fast Scan TV uplink experiment as well as packet to the SAREX package. A few quipped that we might as well throw in the kitchen sink as well. In meetings the Committee held with NASA Johnson Space Center officials, it became clear that STS-35 would not have enough mid-deck locker space available for this full compliment of SAREX experiments. This was principally due to the fact that this mission is scheduled to last ten days, requiring more food and other supplies than most Shuttle flights. At first, it appeared that this simple fact would be enough to keep us off the mission. But, a quick decision was made to shrink the SAREX payload to a size that could be accommodated by dropping the SSTV and delaying FSTV until STS-37 (more on that later) leaving STS-35 with only voice and packet capability. This shrinking was made possible, largely by the development of a very small TNC, the Tasco HK-21, donated to the project by Heath, which markets it in the U.S. Another contributing factor was the availability of a new, much smaller, power supply, the purchase of which was underwritten by the ARRL Foundation. The TNC and power supply were packed by

W5DID and his crew in an existing standard NASA box. This, along with the same Motorola 2 Meter FM HT used all previous NASA approved ham-in-space operations, would make up the entire electronics package. A new side window antenna would round out the Amateur provided equipment. But wait. If we're going to operate packet, don't we need a computer, or at least a terminal? Yes, we do. But, once again, fate was on our side. In the intervening years, since it was first proposed that Ron be allowed to operate packet from the Shuttle, NASA has equipped the orbiter with a general purpose computer for use by astronauts for various applications. This computer, known as the PGSC, is a Grid, a small lap-top, which runs MS/DOS. Incidentally, PGSC, in NASA parlance, stands for Payload General Support Computer. In any case, it has been agreed that one of these machines will be available for use with SAREX at various times during the mission when it is not otherwise occupied.

This last minute change in configuration ("packaging the TNC and power supply in a standard NASA box"), as referred to above, sounds simple. But, it caused yet another major expenditure of effort on the part of Lou McFadin and his group of volunteers at the JSCARC. One fact not appreciated by most of us is that all hardware being fabricated for use aboard the Shuttle must be fabricated from standard NASA drawings. These drawings are required to be prepared to exacting standards. No sketches on the backs of cocktail napkins will do. Nevertheless, once again, Lou and his group came through and the configuration shown in Figure 1 is now officially included in the manifest of experiments to be flown on STS-35.

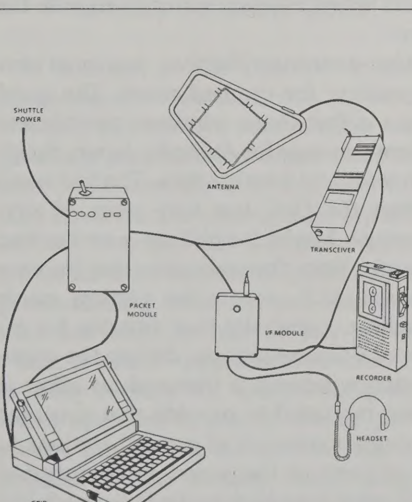

Fig. 1 — STS-35 Configuration.

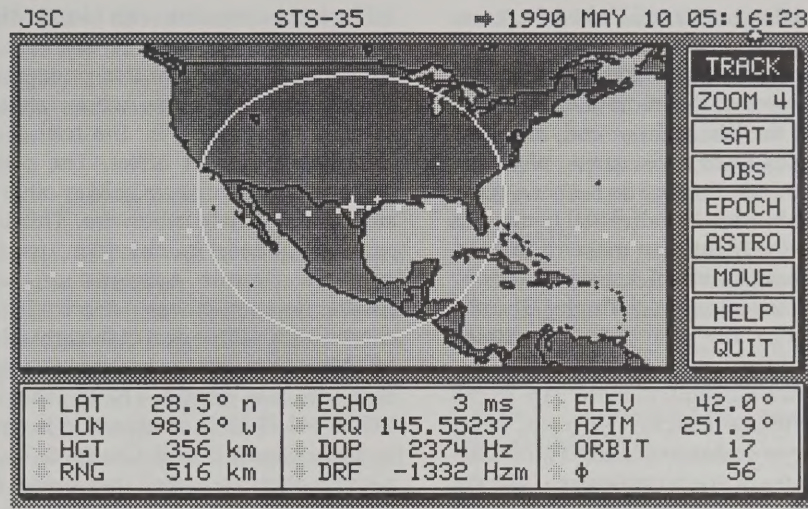

Fig. 2

Problem and Solutions

One of the major objectives of all ham-in-space operations is to expose young people, through Amateur Radio, to technology in general and the space program in particular. In so doing, we also showcase Amateur Radio and possibly gain some new recruits to the hobby. Flight planning for STS-35 presents a major problem in meeting this objective. The combination of the nighttime launch and the planned 28.5 degree inclination orbit causes passes over the U.S. to be at times not appropriate for classroom participation. Crew schedules further limit such opportunities. Background on the reason the orbit selected for STS-35 was chosen as well as limitations presented by crew schedules are presented in the following sections.

The Whys and Wherefores of STS-35's Orbital Characteristics

There are many factors which determine when, where, and by whom a spacecraft will be seen. Among those are the launch time of day, the orbital altitude, and the inclination of the orbit. Let us look briefly at each of these with regard to how they were chosen for STS-35 and how they affect SAREX operation.

First of all let's start with the orbital inclination. The inclination chosen for STS-35 is 28.5 degrees. This means that the ground track of the shuttle will never go north of +28.5 or south of -28.5 degrees in latitude. Why would anyone choose an orbit that covered such a limited amount of the Earth's surface? The answer to that is that a 28.5 degree orbit requires a launch azimuth of 90 degrees, or due east from the Kennedy Space Center. This in turn takes maximum advantage of the Earth's rotational velocity in achieving orbital velocity in the vehicle. If the launch were to be into a higher inclination orbit, which would certainly benefit Amateur Radio operations, more energy would be needed to attain the necessary velocity and a lower orbital altitude would result. This brings us to the next parameter, orbital altitude.

The altitude of the orbit determines how much of the Earth's surface one can see from the spacecraft at any given time. The higher the orbit, the more one can see. For STS-35 there are two constraints. The lower limit is determined by the nature of the primary payload, Astro 1. Astro 1 consists of a suite of four astronomical telescopes which will be used to conduct a series of observations in the ultraviolet and x-ray portions of the spectrum. At a typical Shuttle altitude, the orbiter is still flying through a very thin residual atmosphere. The collision of the vehicle, flying at Mach 25 (!), with the leftover oxygen and nitrogen molecules can cause a considerable glow around it. Since the glow of the night time sky is one thing the astronaut astronomers are trying to avoid, the altitude must kept as high as possible to minimize this glow. Of course, the higher altitude also benefits the Amateur Radio aspect of the flight — since more of the Earth's surface is within line of sight. The upper limit for altitude on Astro 1 is determined by another effect. As one goes higher in altitude the number of free electrons floating about starts to increase. This poses no hazard to the crew but a whole bunch of electrons at high energy can wreak havoc on a piece of photographic film. One of the ultraviolet experiments records its data on film and for that reason, an altitude of 350 km (219 mi.) was chosen. From the standpoint of SAREX operations, this altitude provides line of site paths to as far north as 47 degrees north latitude and likewise as far south as 47 degrees south latitude. See Figure 2 for an example of a pass over the mid-U.S. As you can

see, all of the continental United States except for the very northernmost points will have line of site opportunities. It is unfortunate, however, that most of these passes will be in the late night or early morning which leads us to a discussion of the effects of launch time of day. While not a particular burden to individual hams, this aspect of the flight plan makes it impractical to put on in-school demonstrations by direct communication with the Shuttle. This is why the relay plan, discussed below, is being pursued.

Why does the flight plan for STS-35 call for a nighttime launch? The major effect that must be understood here is quite simple to state. If one launches at night the spacecraft will pass over the launch site generally at night. And, if one launches during the day, it will pass over the launch site generally in the daylight hours. Astro 1 originally had a nice civilized mid-morning launch from KSC. Unfortunately a day launch from KSC, in the north Atlantic, puts the Shuttle over the south Atlantic during the night. What, one may ask, has passing over the south Atlantic during the night got to do with anything? Those of you who are familiar with the topology of the Earth's magnetosphere will recall that over the south Atlantic ocean is a big mountain of trapped charged particles called the South Atlantic Anomaly (SAA). When the Shuttle passes through the SAA many electronic devices in the experiments such as vidicons, image intensifiers, star trackers and the like are affected by these charged particles and are temporarily unable to perform their assigned duties. On an astronomy mission, such as Astro 1, the night time part of the orbit is the most valuable due to the lack of scattered sunlight. Therefore, it was not acceptable to those planning the mission to have half of the night time passes interrupted, and nearly 30% of the total night observing time lost due to SAA passages. In order to have the Shuttle pass through the SAA in the daytime a night launch is required. The most optimum launch time to minimize the effects of the SAA is 06:00 GMT, or 2 AM EDT. This, of course, is not optimum for Amateur Radio in the U.S., since most of the U.S. passes will be during the late evening to early morning.

Frequencies

Table 1 lists the frequencies presently intended to be used for FM voice and packet on both STS-35 and STS-37. SSTV on STS-37 is also expected to use these same frequencies. The FSTV uplink experiment on STS-37 will be in the vicinity of 436 MHz.

The primary pair to be used is 145.55 MHz as the downlink with 144.95 MHz as the uplink. A spacing of 600 kHz was deliberately chosen for this primary pair, to accommodate those whose split frequency capability is limited to the customary repeater offset. The primary pair will be used unless QRM or other considerations dictate otherwise. This is the same frequency combination used on previous Shuttle missions on which Amateur operation was authorized. It was chosen with a great deal of thought relative to 2 Meter band usage in the U.S. and the rest of the world. Note that the 145.55/144.95 MHz combination is present in both Group 1 and Group 4. That is because alternate uplink frequencies from Group 1 would be used over North and South America while those from Group 4 would be expected to be used generally in other parts of the world. The frequency of 145.55 MHz has also been used regularly by the Amateurs operating aboard the Russian Mir space station. Thus, this frequency has become the principal one used for manned Amateur space operations and will probably remain so, well in the future.

Note, that for NONE of the combinations listed is ''simplex'' operation specified. *Do not call the shuttle on the same frequency on which you hear it.* This procedure may be a little strange for packet folks, who are accustomed to working simplex, but everything works the same way as it does when you are operating on a single channel.

Table 1

	Shuttle Transmit Freq.	Accompanying Shuttle Receive Freqs.
Group 1	145.55 MHz	144.95 MHz
	"	144.91
	"	144.97
Group 2	145.51	144.91
	"	144.93
	"	144.99
Group 3	145.59	144.99
	"	144.95
Group 4	145.55	144.95
	"	144.70
	"	144.75
	"	144.80
	"	144.85

A word about frequency deviation for packet operation is in order. Because of the approximately 3 kHz of Doppler implicit in the orbit the Shuttle will be in, it will be best to keep transmit deviation to about 3 kHz. Otherwise, unless you are accomplishing Doppler correction, there may be sufficient distortion on your signal to prevent SAREX from copying you.

Operational Scheduling

Since SAREX is classified as a ''secondary'' payload, the allocation of operating time to it is done after all requirements for the primary payload have been met. Astro 1 is a Spacelab payload, which requires 24 hour/day operations throughout the mission. The implication of this is that Ron's normal on-orbit twelve hour duty shift will be completely scheduled with Astro activities. The other twelve hour period of the day must, of course, include some time for sleeping, eating a couple of meals, performing whatever hygiene activities are required, participating in on-board change-of-shift briefings, AND tending to whatever additional mid-deck experiments are left (like SAREX).

The scheduling folks will always schedule eight hours for sleep whether one actually sleeps that long or not. This leaves four hours of time left to be scheduled out of the 24 in a day. These hours are roughly divided in half with approximately two hours scheduled after the duty shift and before sleep (imaginatively called PRE-SLEEP) and the other two hours scheduled after getting up but prior to the duty shift (You guessed it ... POST-SLEEP!). All crew-tended SAREX operations will have to be scheduled within those two two-hour periods. The initial input which has been given to the flight planners for scheduling purposes is that all of Ron's PRE-SLEEP and POST-SLEEP periods should be listed in the flight plan as SAREX windows. Now, as you may have guessed, this means that whatever part of the Earth the Shuttle is over during those windows is where Amateur stations can be worked. And whatever parts of the Earth the Shuttle does not pass over during those windows are basically left out with respect to direct interactive communications with the crew.

After a sentence like that, you must now be waiting for the bad news. The good news is that those windows provide excellent coverage for Australia, Japan, South America, and South Africa. The bad news is that the U.S. has very poor, if any, coverage. Maybe the bad news isn't so bad though! Since the realization that the continental U.S. won't be getting much coverage, especially that suitable for in-school demonstrations, during the crew-tended windows, a tremendous effort is being mounted to provide that coverage through a network of ground stations in other parts of the world in conjunction with relay links back to the U.S. much like the network that was put together for the AMSAT Launch Information Network Service (ALINS) in support of the recent MicroSaT/UoSAT launches. At this end, a

telephone bridge is to be established to local repeaters — again, along the lines of the one used in the ALINS hookup. Volunteers across the country will be asked to contact local schools and offer to put on demonstrations of Shuttle Amateur voice and packet communications using their local repeaters as the final link to the school. A few schools will be selected to participate in actual two-way exchanges between students and the astronauts via Amateur Radio.

This approach provides a silver lining in this otherwise dark cloud, in that it involves many more Amateurs directly in SAREX operations, and showcases the impressive capability of the international Amateur community to setup a worldwide ground network to support the flight . This last point has just recently been brought to light. As various NASA and industry people have been informed as to how the Amateur community intends to operate on STS-35, their jaws drop in disbelief at the thought of a bunch of hams putting together such a ambitious network before May of this year!

So far we have been talking about crew-tended operations only. That is, real-time voice and packet QSO's with the crew. Packet Robot operations do not require crew attention except for activation and deactivation. The Robot will generally be activated during one of the crew-tended windows and then deactivated during the next one. This gives approximately twelve hours ON and twelve hours OFF for the Robot, with the operational period chosen to cover all of the U.S. passes. Details on the operation of the Robot and other packet modes can be found in the following sections.

Packet — the Key to Many Successful QSOs

In addition to the planned in-school communication sessions, it is hoped that WA4SIR will have the time to make some, generally unscheduled direct voice contacts while over the U.S. and elsewhere. It is, however, the packet radio capability on both missions that will make it possible for far more successful QSOs between ground-based Amateurs and the Shuttle than has been the case on any previous "ham in space" operations to date. This is partly because the SAREX equipment, when operated in any of several packet modes can be left unattended for long periods of time. Greatly contributing to this is the new side window antenna designed and built by volunteers at the Motorola Amateur Radio Club in Shaumburg, IL. The previous antenna, which mounted in one of the upper deck windows, had to be removed when the window was needed for visual observations or photography. The side windows are not normally used during the on-orbit portion of missions.

Packet Radio Details

The HK-21 TNC will be loaded with an upgraded version of the SAREX "ROBOT" software which had been written several years ago to support Ron's originally scheduled flight prior to the shuttle program being put on hold following the Challenger tragedy.

Successful testing of the updated flight TNC software, written by Howie Goldstein, N2WX, was recently completed by W3IWI and others in the Washington area. The AMSAT/TAPR packet folks (specifically Howie Goldstein, N2WX, with cheerleading/prodding/testing by W3IWI) have been preparing this software to take advantage of the added memory capability of the HK-21 over the unit intended to be used in 1986. Because the group was initially lacking some critical information on the way the special VLSI (CPU+SIO+PIO+CTC) chip in the HK-21 works, efforts were, at first, concentrated on getting the special SAREX software running in a "stock" TNC2. Joe Kasser, G3ZCZ, working with Ron, has configured a custom version of his LAN-LINK packet terminal program to run in the Grid laptop.

Ron will have some time for operation of the Amateur Radio aboard the Shuttle, but not very much. One of the beauties of packet is that it can, largely, be operated in various unattended modes. The modes that have been implemented are outlined as follows:

The QSO ROBOT

The goal of the ROBOT is to provide an automated operation which can proceed without much human intervention. The ROBOT software has two main functions:

1. An automatic QSO machine capable of making a complete "legal" QSO under computer control.
2. Beacons which tell who has been worked and heard and send information on shuttle activities.

Let's first take a look at the ROBOT QSO "machine". A minimum "legal" QSO can be defined as the 2-way exchange of information with acknowledgement. The following is an example of a 2-way QSO between W3IWI with the SAREX ROBOT, running the call WA4SIR-1, as seen on W3IWI's terminal screen.

W3IWI types the connect command which is echoed back.

C WA4SIR-1

When the connect is accomplished the following three lines are seen.

*** CONNECTED to WA4SIR-1
#191--- Tnx QSO with the SAREX Shuttle "ROBOT" automatic QSO machine ***
DISCONNECTED

This exchange has been designed to include all the "legal" elements of a QSO:

- The station connects with the ROBOT. In doing so, he transmits information not previously known by the ROBOT — his call.
- By accepting the connection, the ROBOT acknowledges receipt of the information and sends a piece of information, the unique serial number (#191).
- The ROBOT must hear the station's ACK in order to declare the QSO "good" and to enter it into the log. If no ACK is received after a predetermined number of retries, the QSO is not entered into the log. The user knows he had a QSO because he receives a disconnect, and because his call is immediately placed in the "QSL" log.

The ROBOT QSO machine is configured to be working on up to nine simultaneous connections. Back in 1986 when an earlier version of the software was tested from airplanes, using stations in the greater Los Angeles (LA) Basin, as well as in a number of other locations, the maximum number of simultaneous connections any of the testers achieved was about six before the channel caved in from QRM in a Chernobyl-style meltdown.

The "Normal" Beacons

The SAREX software on the orbiter's TNC includes two or three beacons sent down at a pre-determined interval, probably about every 2 minutes. First, the QRZ beacon lists the last 35 stations that were heard. An example of such a beacon packet is shown in Table 2. Each time a beacon is sent, a beacon serial number (#3405 in this case) identifies the epoch to

Table 2. QRZ or Heard List Packet.

```
WA4SIR-1>QRZ <UI>:
*3405-NE3H WB6GFJ K5AR K05I WB3ILO N3ACL N3FWX WA3TSD W3ZM
WA3USG WB3AXC N3GIY KE4TZ G3ZCZ K04A WA3EPT KA3TUU WB3AFL WB3IMM
N3AGG DB2OS DJ4ZC G2BVN 4Z4ZB G3AWL G3AAJ G3IOR JR1SWB JA1ANG
W3HZU W3INK W3GXT N4QQ W3IWI W3IUI
```

Table 3 QSL or Confirming Stations Worked List Packet.

```
WA4SIR-1>QSL <UI>:
NI3F/186 WB2TNL/185 KA3MJM/181 W3IUI/179 WB3AFL/177 NF3N/176
WA3EPT/175 N4QQ/174 WA4SIR/173 W3IWI/172
```

help in sending out SWL cards in the future. When the list of 35 fills up, the oldest entry is dropped off the bottom to make way for a new entry:

Next, the software sends a list of the last 15 stations worked and the QSO seria number for the contact as shown in Table 3.

The QRZ and QSL beacons may be accompanied by another beacon if desired. In this case the address is SAREX, but it could be anything as shown below:

WA4SIR-1>SAREX <UI>:
Trying yet another SAREX software release.
Connect to WA4SIR-1 for a QSO with the SAREX ROBOT.

The Metabeacon

The software also includes a ''Metabeacon'' consisting of numbered ''I'' frames addressed to QST which are also sent periodically, but independent of the QSL/QRZ beacon. The Metabeacon is intended to transmit a longer, up to 1.7 kbyte, instructive text message. The Metabeacon is implemented, in essence, by setting CONPERM ON, RETRY 0, PACLEN 255, MAX 7 and DWAIT equal to the cycle period in the special SAREX TNC code. An example of the Metabeacon is shown in Table 4.

Perhaps it might illustrate how all of this works by imagining that you are the ham astronaut aboard the Shuttle Columbia on Mission STS-35. For the W3IWI QSO shown above, here is what would appear on the screen of the Grid laptop.

*** CONNECTED to W3IWI
*** W3IWI QSO confirmed #191
*** DISCONNECTED

Of course this QSO did not get logged, since W3IWI had already worked the orbiter earlier.

The QSL ''worked'' log is kept in the HK-21 TNC's RAM. Up to 650 entries can be in the list, and the list is retained even when the power is shut off. The log lists only unique contacts. If you work the ROBOT more than once, only the first contact is logged even though you will be given a unique serial number for the later QSOs. The log ignores your SSID, so a contact from K9DOG-1 made after a K9DOG QSO is considered as a dupe.

The TNC's 650 entry long list should last for most of the mission, but it is anticipated that Ron will dump the log once or twice per day to the Grid laptop. In the following example of the TNC's log, the first four digits (0355 for NI3F) are the HH:MM time read from the TNC's internal clock, and the trailing digits (186) are the QSO serial number:

```
Connected-
NI3F     0355186
WB2TNL   0351185
KA3MJM   0252181
W3IUI    0115179
WB3AFL   0001177
NF3N     2346176
WA3EPT   2254175
N4QQ     2231174
W3IWI    2229172
```

In addition, the 35 entries in the ''QRZ'' heard list are also available as shown in the following example. The calls are in the order they were heard. In this case several of the calls near the bottom of the list have been reheard later, and the time reflects the LAST time the station was heard. The * shows that the call was heard via a digipeater, something that should only happen during ground simulations, or if gateways are in use on the ground to allow stations in the far Northern and Southern latitudes to get a contact.

```
NE3H*    01/09/90 04:00:38
NI3F     01/09/90 04:06:57
K1LHJ    01/09/90 03:47:39
WB2TNL   01/09/90 03:51:20
WB3ILO   01/09/90 03:34:58
N3ACL    01/09/90 03:46:34
N3FWX    01/09/90 03:49:18
WA3TSD   01/09/90 03:22:29
WA3USG*  01/09/90 03:11:07
WB3AXC   01/09/90 02:59:40
N3GIY    01/09/90 03:51:45
KE4TZ    01/09/90 03:59:11
KO4A     01/09/90 03:28:45
WA3EPT   01/09/90 03:56:55
KA3TUU*  01/09/90 02:26:19
WB3AFL   01/09/90 04:05:05
WB3IMM   01/09/90 02:30:24
N3AGG    01/09/90 02:57:58
K3TAZ    01/09/90 03:13:35
KA3MJM*  01/09/90 03:00:16
NW5E     01/09/90 02:18:31
KC3ID    01/09/90 02:10:45
W3SST*   01/09/90 02:07:53
WB4APR   01/09/90 01:47:57
N3ACJ    01/09/90 03:17:29
N3BRQ    01/09/90 01:41:45
KB3QK    01/09/90 02:16:40
W3HZU    01/09/90 04:05:08
W3INK    01/09/90 03:16:05
W3GXT    01/09/90 04:07:37
N4QQ     01/09/90 04:08:21
W3IWI    01/09/90 04:08:17
W3IUI    01/09/90 01:15:08
```

Some Useful Software

Joe Kasser, G3ZCZ, has set up LAN-LINK for the space segment on the Grid PC which will automate most of the functions Ron will have to do to set up the TNC, loading the beacons, saving the logs, etc.

The SAREX part of LAN-LINK was designed for both the space segment and the ground segment.

LAN-LINK has a number of features specially designed for ground stations trying to work the SAREX, copy telemetry from the MicroSats and other special activities as described below.

The Attack or ''Go For It'' Mode.

If the Attack Mode is set, LAN-LINK will issue a connect request to WA4SIR-1, or any other desired station, whenever a packet sent to or from it is heard. Be careful using this feature, as it has the potential to cause a great deal of QRM. It can also be cleared by another station connecting to you and telling you to ':QRT:'.

Blind Connect Scheduler

In case you think that the Robot may be turned on in the middle of a pass before you hear a packet, you can give LAN-

Table 4 Example of the Metabeacon Packets.

```
WA4SIR-1>QST <I S1 R0>:
WA4SIR-1 is testing the Shuttle Amateur Radio EXperiment (SAREX) packet
"ROBOT" system on board the Shuttle Columbia Mission STS-35. Connect to
WA4SIR-1 for an automatic QSO with the ROBOT QSO machine.

WA4SIR-1>QST <I S2 R0>:
Your ROBOT QSO will be automatically logged and you will receive a serial
number for the QSO. Your successful QSO will be announced in the beacon
addressed to QST. All stations heard by the ROBOT are announced by the
beacon addressed to QRZ.

WA4SIR-1>QST <I S3 R0>:
In addition a longer beacon, up to 7 frames of up to 255 bytes each, called
the "Metabeacon" addressed to QST will be used to give mission status
information periodically. Here is an example of a possible such message.

WA4SIR-1>QST <I S5 R0>:
If you work the ROBOT multiple times, only the first successful QSO is
logged. The log discards your SSID so you can't "cheat" & get duplicate
QSOs by using different SSIDs.
73 de Ron, WA4SIR
```

LINK the start time and the end time of the pass and the time interval between the connect/call attempts. At the given start time, LAN-LINK will issue a connect request, and keep trying until either it succeeds or the pass ends. The first connect that goes through will inhibit the scheduler.

Telemetry Capture

LAN-LINK can also be configured for telemetry reception so as to capture-to-disk any packets addressed to or from the SAREX callsign. The capture-to-disk file is opened by a packet header containing the SAREX call, WA4SIR-1, and closed by another packet header not containing that call. Packet headers are considered to be lines with a '>' character in them. LAN-LINK thus considers both of the lines below as packet headers.

N4QQ*>G3ZCZ
N4QQ BBS>

LAN-LINK users may also set up these features for copying telemetry from the MicroSats.

QSLs

QSL's are always the culmination of a successful, and sought after, QSO. This important aspect of Amateur Radio has not been forgotten. Cards for stations who have successful QSOs with the Shuttle will be made out automatically based on the QSL "worked" log described above.

SWL cards for the people who are heard by SAREX ROBOT must be handled differently. The TNC simply does not have enough on-board RAM to retain a heard list any longer than 35 entries; the QRZ beacon will send the entire heard list every minute or two, along with the beacon serial number. Anyone wanting an SWL card will have to send a hard-copy listing of the QRZ in which their call appears, complete with the beacon serial number. Alternatively, they can send in the whole packet with the header as captured, via packet radio to a collection point to be announced. More detailed procedures will be announced later.

Then and Now

In 1986, the TNC we were going to use was a CMOS, hardened TNC2 equipped with 16 kbytes of RAM, drawing about a Watt of power, and packaged in an 8 inch x10 inch x 1.5 inch aluminum box. The 1990 version is flying the CMOS VLSI TNC made by Tasco and sold by Heath as the HK-21, which has 32 kbytes of RAM and draws about 1/4 Watt. The HK-21 has been modified to mount in a metal box and has been "hardened" a bit, but is really quite stock.

In 1986 it was planned to use a hardened Radio Shack TRS-80 Model 100 with 32k of RAM and no disk. The 1990 version uses a Grid laptop PC, full of RAM, equipped with a hard disk and capable of running standard MS-DOS software. In 1986, we had to prepare the Model 100; in 1990 the Grid is a standard piece of shuttle hardware, which we can use when it is not busy doing something else.

The 1986 software was based on a 16k TNC2. The extra RAM, now available in the HK-21, is used to store the large, 650 entry QSL log. The 1990 software is built on the yet-to-be-released TAPR 1.1.7 platform which has benefited from several years of evolution.

Information Dissemination

Dissemination of Shuttle information to those participating as well as all interested Amateurs will be via a system of key stations, namely WA3NAN, at the Goddard Spaceflight Center Amateur Radio Club located, in Greenbelt, MD., W5RRR, at JSC in Houston, and W6VIO at JPL, in Pasadena, CA. These stations will operate on hf and vhf 24 hours a day, carrying official NASA supplied voice communication between Mission Control in Houston and the Shuttle crew. This is basically the same service that they have performed on all non-DoD Shuttle fights for the past several years. To further provide information specific SAREX communication opportunities and related information, bulletins originated by Amateur volunteers stationed at JSC will be fed via a computer network to these stations and others including W1AW. The Metabeacon may also be used for announcements.

Responsibilities

ARRL is to handle educational support, publicity, radio club participation, etc. including the recruiting and coordination of the volunteers to put on the in-school demonstrations. An article by Rosalie White in February 1990 *QST* kicked off this effort. AMSAT is to handle all technical aspects, including establishment of the overseas ground stations and network relay operations. The JSCARC will prepare and test all flight hardware and provide all flight planning including in-flight changes and support. AMSAT, in addition to its network chore, has, with the help of TAPR people, been developing and testing the special software for the TNC as described above.

Another Opportunity

Ham-in-space fortunes took another jump when Ken Cameron, a Shuttle Pilot, secured his license and received the call KB5AWP. Ken is scheduled to fly on STS-37. Another joint ARRL/AMSAT letter proposing Amateur operation on this flight went to NASA Headquarters and was accepted so plans are underway for yet another SAREX. This time, it appears that there will be room for the entire package, so plans are underway for two-way SSTV (a la STS-51F) as well as voice and packet. In addition, plans call for the addition of a fast scan TV (FSTV) uplink experiment, most of the equipment for which has been provided by the Amateur Radio Club at Motorola in Schaumburg, IL — the same group that did the new antenna. The antenna includes provisions for receiving 70 cm ATV signals. *If we can successfully accomplish reception of fast scan TV aboard the Shuttle, it is believed that it will be the first time that FSTV has been sent up to a spacecraft.* Although NASA has downlinked hours of FSTV, they have yet to uplink it. So, hams have a chance for a first. This will truly be an experiment and it is not certain that it will be successful as link calculations are not encouraging. However, it is planned that maximum effort will be made by a few dedicated groups across the southern part of the country, where Shuttle coverage will be best. It is hoped that their effort will result in the reception of at least a few minutes of acceptable color video. This will be enough to declare the experiment a success and score a first for Amateur Radio. Success should also have great impact on publicity during and after the flight. The SAREX configuration slated for STS-37 is shown in Figure 3.

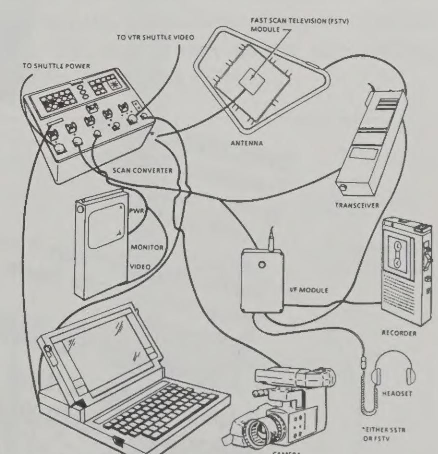

Fig. 3 — STS-37 Configuration.

(Continued on page 14)

ANTENNAS FOR MICROSAT GROUND STATIONS

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So you think that you know all about the antennas that you will need to use with the upcoming MicroSat (PACSAT) operations — but do you really? Recent examinations and disclosures are in the process of throwing some of the old ideas out the door. Let us examine this information and see just what a good antenna should look like, and how to build one.

Bob McGwier, N4HY, and others who completed the assembly and tests on the MicroSats found that using a PSK modem with a TNC can be just a little tricky if the incoming signal is too strong. They found that the modem can lock up on one of the sidebands of the signal, with the result that the decoded signal is digital trash that is not understood by the TNC. It is expected that this capability of tracking on the wrong sideband should not be a problem if the received signal is not too strong. However, the signals from the MicroSats are strong and the use of high gain antennas is totally unnecessary. Low gain omnidirectional antennas thus appear to be in order.

Use of excessive transmitter power and antenna gain on the MicroSat uplink is a socially unacceptable practice, just like in other Amateur Radio communications. This particular excess constitutes FM receiver capture effect on the spacecraft to the detriment of the Amateur community.

One low-gain antenna that was commonly touted for low Earth orbit (LEO) service in the early days of the OSCAR program was the circularly polarized (CP) Turnstile-over-Reflector antenna. A number of us built these antennas for the 1983 STS-9 mission of the Space Shuttle Columbia, with Owen Garriott, W5LFL, on board. The turnstile was supposed to be a "cool" antenna to use for that mission, but the guys in their automobiles with 5/8 wavelength antennas just plain trounced us with their reception of Columbia on the horizon. The turnstile antenna used for that mission was a flat failure, as it will also be if used for the MicroSats! There must be some form of systematic failure in our expectations of the turnstile antenna to cause this situation.

Sure enough an article by Courtney Duncan, N5BF, pointed to the antenna problem[1]. Courtney's conclusions about the location of a LEO satellite with respect to a ground station are repeated in Figure 1. This partial polar plot shows that about 52% of the time a LEO satellite will be below 10 degrees elevation, 76% of the time below 20 degrees, about 90% of the time below 30 degrees, and the visibility time above 60 degrees elevation is vanishingly small. One look in an *ARRL Antenna Handbook* at the vertical radiation polar plot for a turnstile antenna will show that it does not receive signals very well if they are coming in from an elevation angle below 30 degrees. In a sense, the turnstile antenna has been shot down in flames.

There is another problem with the use of a CP antenna, like the turnstile, on a MicroSat. The spacecraft transmitted signals are right handed circular polarized (RHCP) but that is only off the bottom end of the spacecraft, the -Z axis. Attitude control of the MicroSats provide for a magnetically induced tumble of 2 revolutions per orbit, and a sun driven spin of 0.2 to 1.0 revolutions per minute. This results in a pretty complex spacecraft motion. We found out on AMSAT-OSCAR-8 that the sense of circularity on the received signal at any ground station changed as the spacecraft travelled along its orbit, and there was no consistency in the CP sense. The building of a fixed sense (RHCP or LHCP) receiving antenna is viewed as counterproductive to good communications.

Let us now consider antennas that do perform well at low angles of radiation. We can start with an elementary ½-wave vertical. This is the fundamental antenna, no ground plane or collinear arrangements, just a plain vanilla ½-wave vertical antenna. Figure 2 shows the relative gain performance for a vertical ½-wave antenna as a function of elevation angle above the horizon, and it is not bad for the first 60 degrees. Also shown in Figure 2 is the reduction of signal path loss from the satellite, as it gets closer to the ground station as it becomes higher in the sky. A reduction of path loss is a gain in overall performance, and you will note that this gain is happening faster than the loss of the ½-wave antenna. Plotting the sum of these losses (or gains) gives us the third curve on Figure 2, or the total system performance. Note that this system performance doesn't even return to 0 dB until an elevation angle of 70 degrees is reached. This means that much more than 95% of the visibility time for a MicroSat is covered by useful omnidirectional antenna performance. Just think, no rotators, no tracking, no fuss, just communications. We will only be concerned about scheduling satellite AOS and LOS.

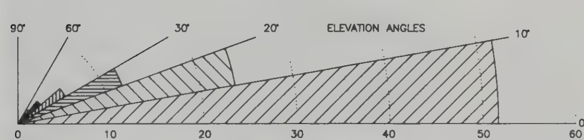

Fig. 1 — MicroSat visibility vs. elevation angle.

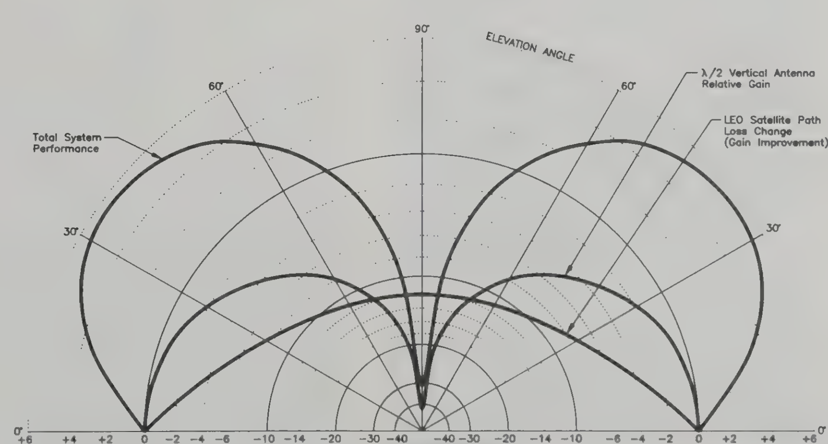

Fig. 2 — Satellite and antenna performance.

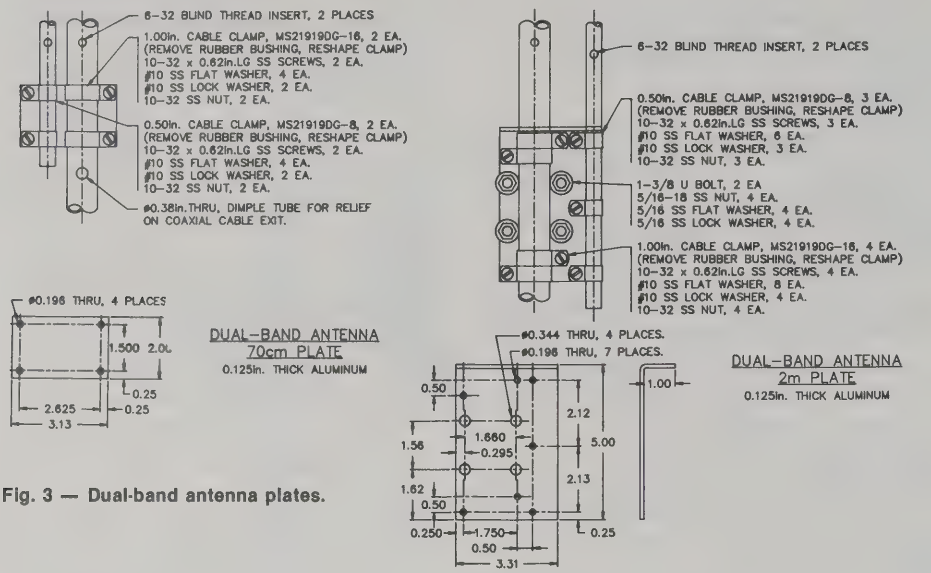

Fig. 3 — Dual-band antenna plates.

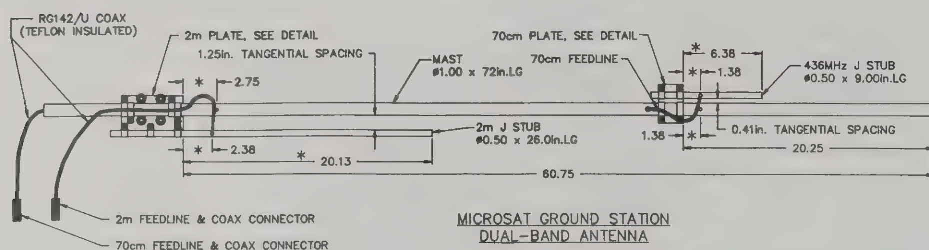

Fig. 4 — Dual-band antenna assembly.

An additional note of caution is that vertical omnidirectional antennas can be overdone. The use of multi-element collinear antennas may provide too much gain on the horizon because the main lobe of those antennas is below an elevation angle of 30 degrees. The user of such an antenna would have to do the equivalent cross plot for the system performance shown in Figure 2 to know how his collinear will perform.

With all of this discussion about antenna performance, one can ask if there is some antenna configuration that will do the job, is low cost, and most of all is KISS *(Editor's note: That's Keep It Simple Stupid!)*

An AMSAT member, WD8KNI, brought to my attention a possible solution that he spotted in an old copy of the *ARRL Handbook FM and Repeaters for the Radio Amateur*, the Third Printing, 1976[2]. This dual-band J pole antenna scheme looked like it was just the item that was needed, and a 2M and 70cm version was quickly built. It needs to be noted that the J pole antenna is fundamentally an end-fed ½-wave antenna that uses a ¼-wave long transformer section to supply the very high feed voltage. It is an ideal end mounted single mast antenna. Another candidate for an omnidirectional MicroSat ground station antenna is the coaxial antenna, but building a dual band single unit assembly might be a triaxial problem.

The dual J pole antenna is a pretty nifty answer for the single assembly of two ½-wave antennas. The upper 70cm antenna does not know the lower two-meter antenna exists, it thinks it's just a support for the 70cm unit. Similarly, the two-meter antenna just has a bit of a fat top that does not affect tuning at all.

A lot was found out about J pole antennas in trimming this job. Nearby conductors within two wavelengths can detune the J pole, and the mast and J elements want to be very close to the theoretical free space measurements for best performance. The result of this design and test effort is shown in Figures 3 through 8. Materials chosen for this antenna are readily obtainable from common sources, odd items are avoided. For instance, the main mast was originally going to be a 1¼ inch OD aluminum tube, but that tubing isn't really all that common. Just about every hardware store has 1.0 inch OD aluminum tube, or shower curtain rod, and the design was built around a 72-inch long piece. The J elements are of ½-inch tube from the same aluminum rack.

The remaining pieces needed are shown in Figures 3 and 4, and should be readily available. Note that the clamps used for holding the pieces together are taken from common aluminum clamps that have rubber bushings to be used for wire bundles. I removed the rubber parts and used a pair of water pump pliers to reshape the clamp over a solid piece of aluminum bar the same size as the tubing. Clamp the bar stock in a vise and go to work and you will have the task done in a few minutes. You may need to redrill the holes in the clamp to make sure it will tightly grab the tubing. Using all stainless steel screws, nuts, flat washers, and lock washers is highly recommended. Most hardware stores have this stainless steel hardware just waiting for you to purchase.

Careful tuning of the antenna by adjusting the noted dimensions can result in a performance with near zero reflected power at the design center frequencies. Figure 5 shows the completed assembly, in my very shady Florida back yard. Figures 6, 7 and 8 show some of the details of the 70cm and two-meter feed points and brackets. It is very important that you go to the expense of using the RG-142/U coaxial cable for these feed points, as the center conductor of the coaxial feed line is exposed to the weather elements. The RG-142/U is an all Teflon construction that will withstand the weathering without adverse ef-

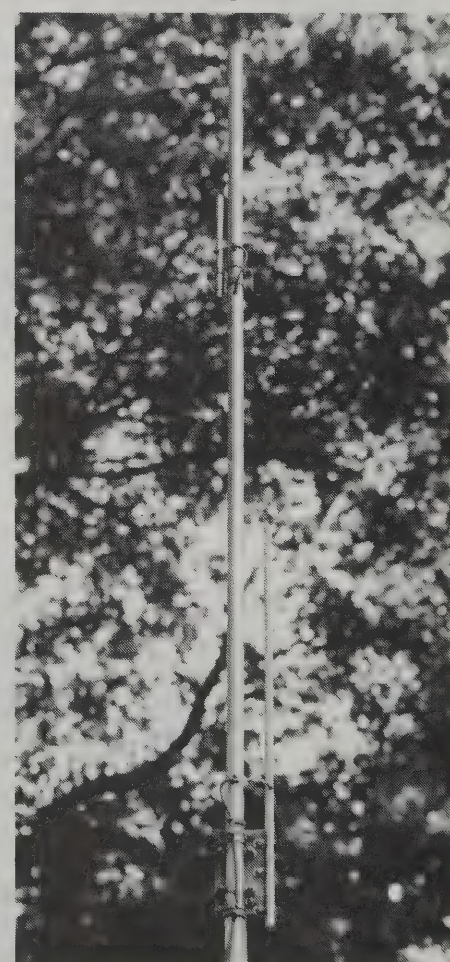

Fig. 5 — Dual Band Antenna assembly on the test stand.

fects. Any lesser coaxial cable can be expected to seriously deteriorate in short order.

Further protection of the coaxial cable from the effects of weather elements can be obtained by using a suitable mastic, such as ''Coax Seal'' around the center conducter where it exits the outer jacket. The purist may also want to close the top ends of the tubing. This is not necessary in Florida, but some may want to do this closure. Small wooden plugs carved to fit and bonded into the tube ends with RTV sealant would do the job very well.

Operating experience with signals from the cluster of MicroSats shows that when the antenna is in the clear (not RF blocked by trees, buildings or other objects), it will provide resounding reception of the satellites once they are clear of ground clutter. This condition is usually achieved within 30 seconds of the spacecraft rising above the local horizon. While PSK packet lock can be obtained with rather noisy signals, reception is enhanced with the use of a modest, 1-dB NF GaAsFET preamplifier.

I will be looking forward to packeting all

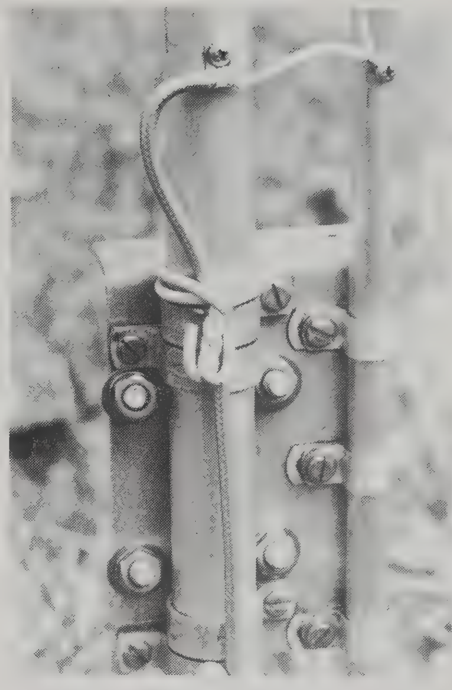

Fig. 6 — Lower antenna two-meter feed point and mounting bracket assembly. Note the use of #12 TW house wire as a cable wrap to hold the RG-142/U coax cable in place on the base. Also note the use of the small cable clamp soldered to the coax braid at its attachment point. Both the center conductor and braid attachment are held to the elements with #6-32 stainless steel screws into aluminum blind nuts purchased at the hardware store. All intermetallic contacts are coated with an aluminum joint compound to prevent corrosion and poor electrical properties. Thomas & Betts Cat. No. 21059 has given me excellent service over many years.

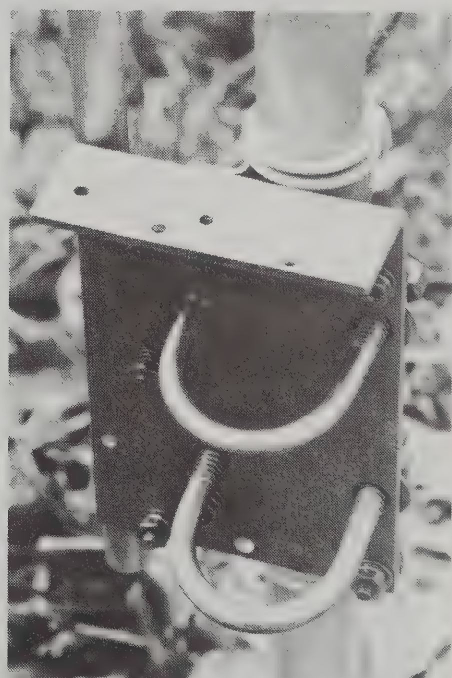

Figure 7, Backside view of the two-eter base bracket, showing the U-Bolts provided for mast mounting. This bracket has an "L" bend to prevent the antenna from sliding down the mast. The particular bracket was obtained at a local surplus store, and you can note that I spent just sixty cents on this item.

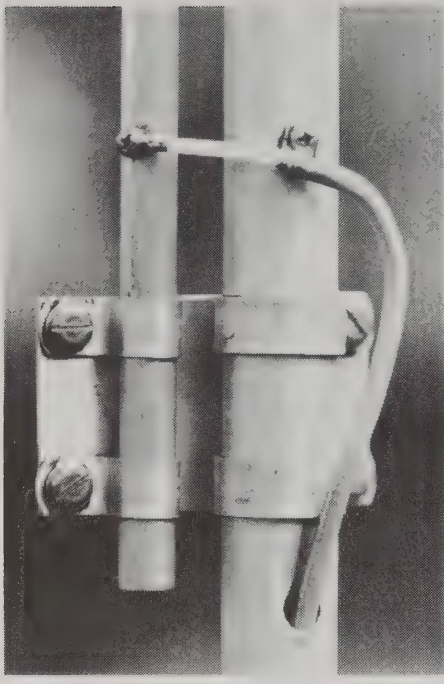

Figure 8, Top antenna 70cm feed point, a simple plate and clamps. It is pretty important to provide an easy exit for the RG-142/U coaxial cable at this point, as the coax is pretty stiff. I drilled a 3/8-inch hole and carefully deburred all edges. Then a ¼-inch pin punch was inserted into the hole and the tubing was dimpled underneath and pried up a little on top. This metal deformation was just what was needed for the coax cable exit.

of the satellites caring as to where exactly the PACSAT is located, but just knowing that it is in view. See you on the new OSCARs.

References

[1] A Method for Evaluating Antennas For a Low Earth Orbit Mission, Courtney Duncan, N5BF, *AMSAT-NA Technical Journal*, Volume 1, Number 2, Winter 1987-88.

[2] Page 95 notes "A Combination 6 and 2-Meter J Pole" antenna, with credit given to W5WEU.

SHUTTLE MISSIONS

(Continued from page 9)

Summary and Status

Current plans for STS-35 call for SAREX to carry the Motorola HT used previously, plus a small packet radio TNC (a modified Heath/Tasco HK-21 "pocket packet") and the side window mounted antenna from the Motorola ARC. The TNC will be used with one of the PGSC Grid MD-DOS lap-top computers now carried in the orbiter. STS-37 is to include the same functions plus two-way SSTV capability and a FSTV uplink experiment.

That's where we stand right now. Equipment and software are ready for both STS-35 and STS-37. Flight dates are currently May 9, 1990 for STS-35 and November 1, 1990 for STS-37. These dates represent changes from the previously announced dates of April 26 for STS-35 and June 4 for STS-37.

References

Rosalie White, WA1STO, "Amateur Radio is Back on the Shuttle!", *QST*, February 1990, pg. 46

CONSTRUCTION OF THE TUCSON AMATEUR PACKET RADIO (TAPR) PHASE SHIFT KEYING MODEM

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Introduction

Two of the new MicroSats in orbit have packet store-and-forward bulletin boards (AMSAT-OSCAR-16 (PACSAT) and LUSAT-OSCAR-19). The modulation technique used by these satellites is Phase Shift Keying (PSK) because PSK has about a 6 dB advantage over FSK, and when dealing with potentially weak signals from satellites, we want to make use of all available technical advantages we can get. This is the same modulation scheme as was used on the Japanese Fuji-OSCAR-12 satellite and Fuji-OSCAR-20 which was launched on February 7, 1990. Most people who are on packet, and especially those who are also on satellites, will only need to add a PSK modulator/demodulator (modem) to their existing station to exercise the capabilities of these MicroSats. The other two MicroSats use either standard FSK packet or PSK packet for their telemetry, so this equipment can also be used to monitor the health of all four spacecraft, a fascinating aspect of Amateur satellites all by itself. This article focuses on one particular aspect of getting set up for the MicroSats: Building the TAPR 1200 baud PSK modem[1].

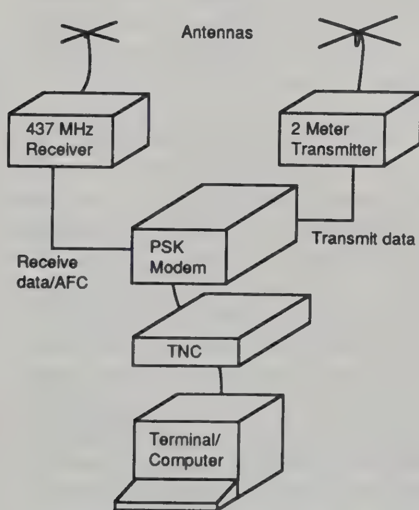


Fig. 1 — PSK station components.

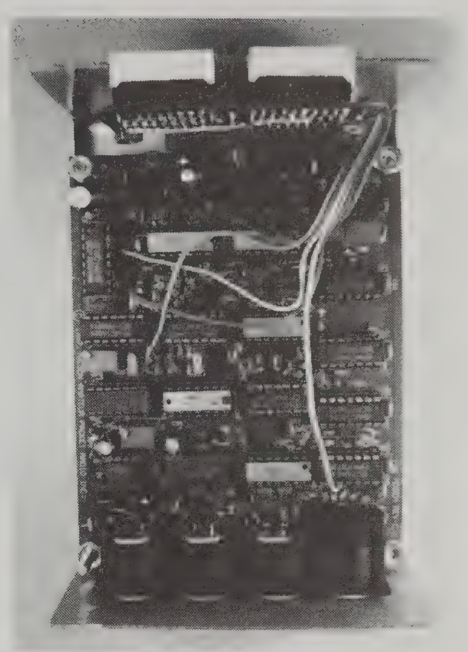
Your regular TNC will need to be slightly modified to use with the PSK modem. The modification amounts to setting up the 20-pin header in the TNC so the FSK modem portion of the TNC can be disconnected and the PSK modem used in its place. On most TNCs this task includes cutting a couple of traces on the bottom of the board, and adding a header. There has been a problem interfacing PSK modems with some TNCs (like the AEA PK-232) because a clock signal is needed by the PSK unit, but that situation has now been remedied with the availability of a kit from TAPR[2].

The TAPR PSK modem comes as a kit of parts. You will only need to add an enclosure and a few additional bits and pieces, such as PC board standoffs, to finish the unit. Once connected to your TNC, the unit has a switch which allows you to flip between normal terrestrial FSK packet and PSK satellite operation.

Hints and Kinks

The following notes are designed to make your construction of the TAPR PSK modem easier and more enjoyable. They were gathered from several sources (special thanks to Bruce, WB9ANQ), but primarily from the enjoyable hours I spent building three of these units (my own and the two used to test the MicroSats at the AMSAT Boulder laboratory). I offer no guarantee the tips will work for you, of course, but they are offered in the spirit of helping you get on the MicroSats as painlessly as possible. I suggest you read through this entire article *and* the TAPR manual before you begin construction.

I do not recommend the Radio Shack (RS) box mentioned in the TAPR manual (RS part no. 270-252). It has been discontinued (you may find them in short supply, but "sale" priced!). It is really a squeeze to get the main board and the display board into that box (Note this close spacing in the photo). A better choiced is a slightly deeper box, so there is more room between the main and display boards. The



supplied panel labels can then be cut into pieces and applied over the holes for the switches, etc. on the front and back panels. For the recommended box, the standoff lengths that work well are ¾ inch for the main board, and 3/8 inch for the display board. There are no 3/8 inch standoffs in the recommended RS package of assorted standoffs (RS 276-195), but ½ inch standoffs can be cut down to 3/8 inch.

If you do use the recommended box, you will find that display board JMP 100 *will* get in the way no matter whether you install it on the front or on the back of the board. It is possible to cut it off and install it on the back of the board, but it will be difficult to get a push on header on it because C5 and C6 on the main board are in the way. My suggestion is to decide if you want the signal strength LED display to operate as a bar or moving spot and install a wire jumper on JMP 100 accordingly when assembling the board. However, be aware that if you change your mind, unsoldering the jumper can result in lifting the rather delicate circuit board traces and pads. In operation it is important not to over drive the modem with too much audio, but both the moving dot and the bar graph provide excellent level indicators. The choice is largely a matter of taste. Alternatively, in a slightly larger box (the LMB OH-743 works well), in place of the two pin header at JMP100, install two wire wrap pins on the back of the board and cut them off so a push on header will just fit.

The PC boards will go in the recommended (or other) box more easily if you mark the mounting holes for the standoffs using the bare PC board as a guide *before* you mount any parts on the boards. When aligning the holes for the main board, line the back of the board up so it touches the

back of the enclosure. That will leave maximum room for the display board, and cause the DIN connectors to fit snugly against the back of the box, making them more stable. An alternative to drilling the holes in the back of the box for the DIN connectors might be to use a nibbling tool or hack saw to notch out one rectangular section through which all the connectors can be accessed. When mounting the display board, make sure that the ends of the bolts do not touch the main board. In the RS box it may be necessary to cut off these bolts to get them just long enough to catch a nut, but not so long that they touch the main board.

You will only need about half of the length of ribbon cable supplied because the required wires can be separated out of the first couple of lengths you cut. The insulation of this cable will melt if too much heat is applied when soldering, leaving more bare wire than you will probably like. Either use very little heat when wiring the switches, or use heat shrink tubing over the connections. I recommend heat shrink; 0.15 inch OD works well, because it adds considerable stiffness and prevents breaking the wires off the switch lugs as you fumble the whole octopus around finishing it up and mounting it. Be sure to avoid heating the heat shrink as you solder or you will never get it over the lug on the switch.

I suggest lengthening the ribbon cable pieces by an inch or so (especially the display board cable) to avoid stress on the connections when assembling everything together. If you use a deeper box don't forget to add some additional length to the display board and switch cables.

Note that the drawing on page 23 of S3 (Figure 7 in TAPR manual) is incorrect. The instructions in the text are correct. Just exchange the GREEN and BROWN labels on the drawing and you will come out okay. At least one builder found the ribbon cable provided with the kit contained different colors and the instructions for wiring the switches had to be redone to match the colors of the cable. The exact colors don't really matter, just be sure the result matches the schematic (Sheet 1 of 1 "FRONT PANEL SWITCHES AND INTERCONNECT"). Be especially watchful of the Green and Blue wires being reversed in the cable. The colors that match the text are: Black, White, Grey, Violet, Blue, Green, Yellow, Orange, Red, Brown. If you end up with colors in the cable that are different, a cross reference table will help, or purchase a length of cable with the right colors!

Be very careful when bending the leads of the ceramic capacitors to fit them into the PC board holes. If you crack the case, the capacitor will be open and you will spend frustrating tens of minutes troubleshooting (usually when the satellite is imminently due to come over the horizon!)

Testing and troubleshooting will be greatly facilitated if you install headers and/or wire wrap pins in the following test point holes. Some are too small to take a wire wrap pin, in which case a cutting from a LED or capacitor lead works fine. These are all on the main board and are marked.

The supplied 3-pin header at JMP 3
A pin at point 21
A pin at point 23
A pin at point TP2
A pin at point TP1
A pin at point RXD

Testing will also go faster if you make a test lead. Use RS test clips that have hook ends like miniature scope probes. Put one on each end of about a 6-inch piece of hookup wire. This is particularly handy when you place the unit in analog loop back mode by connecting the center pin of JMP 3 to the ungrounded end of JMP 8. If you sense an echo of the voice of experience here, you're right!

The instructions on interfacing to the TNC 2 also apply to the MFJ 1270B, 1278 (and probably other MFJ models also). The 1278 is an enhanced TNC 2 clone, and if you follow the instructions for the TNC 2 you will find the right header, transistor, etc. on the 1278 PC board. Route the cable out the back of the case through existing slots. Don't forget to do that *before* you put the DIN connector on the other end.

If your TNC, radio(s) and PSK modem will sit close together, then the supplied length of shielded grey wire will be adequate for all the required cables. Otherwise you will need to obtain more. Be sure it is shielded. Duplex operation requires the best possible isolation between transmit and receive station components. One of the required cables is a standard audio cable available from RS and stereo stores. It's the one with a 5 pin DIN on each end, and connects the radio port of the TNC to the "audio" port of the PSK unit. If you hate soldering DIN connectors like I do, this is a good buy.

As you work your way through the INITIAL TESTING section starting on page 29 you will find places where you move from one test to another and the instructions on how to set switches, place jumpers, etc. for each test are not especially clear. Mostly it is a case of not being instructed to disconnect something. If you are aware of this you won't get caught chasing a nonexistent problem because you left a signal injected or switch in the wrong place. This is where a read-through of the circuit description will greatly speed alignment because you will understand what you are aligning and why. Using a highlighter to mark the test points on the parts layout diagram will also save frustrating minutes searching for an elusive TP or pin when you are anxious to get on with the alignment and test.

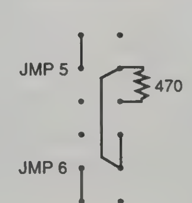


Fig. 2 — Jumper configuration for ICOM radios.

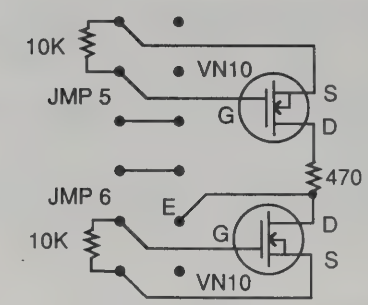


Fig. 3 — Jumper configuration for ICOM radios, FET method.

Be sure when you start testing, that you have the STEP switch in the center or OFF position, and that no cables are connected to the TNC or radios. When you get to the point of trying it out on a real signal, the test tape available from AMSAT HQ will save you having to wait for a real time pass[3]. Remember however, that the tape does not contain any Doppler effects, so once you start copying real signals, you will have to learn to tune the receiver while copying signals in the presence of the Doppler effect. You can then also test the modem AFC feature.

The suggested setup of JMP 5 and JMP 6 for ICOM radios on page 45 (Figure 14) isn't quite right for the IC471, the IC475, and similar ICOM radios. The ICOM radio frequency shift UP/DOWN circuit works as follows: When microphone connector pin 3 is brought to ground the radio steps UP and when pin 3 is brought to ground through a 470-ohm resistor the radio steps DOWN. As stated in the TAPR manual, the optical coupler used in the modem will not provide a solid enough ground to make the radio step UP. Three ways to work this problem have come to my attention. The circuit in the TAPR manual can be slightly modified as shown in Figure 3. Note that the VN10 associated with JMP

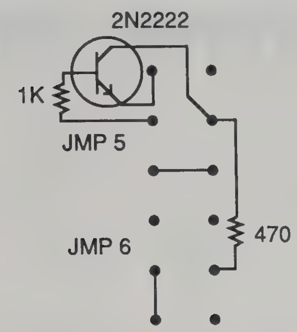


Fig. 4 — Jumper configuration for ICOM radios, transistor method.

6 provides a direct ground to the center-right pin of JMP 6 (E), while the VN10 next to JMP 5 provides a ground through the 470-ohm resistor to that same pin. That pin is connected within the modem to pin 3 of J4, the uhf radio jack. In your interface cable J4 pin 3 should be connected to pin 3 of the radio microphone jack. Several builders have tried a different type of FET than that shown (VN10's) without success. A second method is shown in Figure 4. This method uses a 2N2222 to obtain the solid ground necessary to make the radio step UP, and the internal resistance of the optical coupler to make it step DOWN. Note here also that only J4 pin 3 is connected to the radio microphone jack. A third method takes advantage of the fact that the MicroSat orbit dynamics will almost never result in a need to have the radio to step UP (according to the experts). If you are willing to live with no ability to step UP, the easiest way to get this neat little box on the air fast is to install the push on jumpers as described in the manual for radios that want to see a ground (page 43, Figure 12) and wire the DOWN output (J4 pin 3) to pin 3 of the radio microphone connector. The PSK modem will send a ground through the optical coupler, and it will be close enough to the desired 470 Ohms that the radio will step DOWN very nicely! This is the method I'm currently using. I have not measured the actual resistance in the optical coupler, and it will probably vary depending on the actual component in the modem kit, so I do not recommend this as a permanent solution. But it should get you on the air with AFC quickly.

I found on tests with ICOM and Kenwood radios that the audio gain control had to be set so low to avoid over driving the PSK modem that we couldn't hear the signal from the speaker. That made it somewhat more difficult to assure initial problems copying satellite packets were *not* from a bad signal. Adding the audio level control suggested by TAPR to the PSK modem would solve the problem, as would adding a dropping resistor or a 10-dB pad to the cable. A resistor could also be added across points 9 and 10 on the main circuit board. The exact value needed will depend somewhat on your radio, but I found that 50k ohms worked fine for the MicroSat Lab units with both brands of radios.

I would be delighted to hear from others who have experience building this unit, and will publish any additional hints received. Good luck and see you on the new birds!

References

[1]The PSK kit is available from TAPR, Post Office Box 12925, Tucson, AZ 85732, (602) 323-1710.

[2]The PK232 mod kit is also available from TAPR.

[3]A test tape is available from AMSAT Headquarters for a donation of $15.

AMSAT NEWS

AMSAT-NA Appointments

AMSAT Vice President for Operations, Courtney Duncan, N5BF, announces the appointment of Harry Morton III, WB2IBO, AMSAT-NA Technical Coordinator for Digital Gateways. Harry will be close to developments in packet message forwarding via the recently launched PACSATS. He will be the AMSAT point of contact for those wishing to participate by 1) configuring packet bulletin boards for PACSAT access and automatic PACSAT forwarding, 2) establishing PACSAT relays for use by terrestrial packet bulletin boards, or 3) establishing PACSAT relays for use by terrestrial end users who do not have their own satellite capability.

Harry is now establishing a mailing list consisting of those who intend to set up such stations. He will be operating a PACSAT node himself and will be available for consultation with those who wish to put other nodes on the air and maintain them for reliable Amateur Radio satellite access. He may be contacted at 261 N. Chestnut Street, North Massapequa, NY 11758 for additional information.

MicroSat Telemetry Decoding Programs

These programs are available from the AMSAT Headquarters Office, 850 Sligo Ave., Silver Spring, MD 20910, 301-589-6062

Telemetry decoding/display software for the PC are available from the office in return for a $5 donation to AMSAT. The same software is available on Compuserve and the DRIG (AMSAT) telephone BBS (214-394-7438).

There are a number of programs included on this disk. Except where indicated, each is an archive that contains documentation, source code, and telemetry examples.

TLMDC3.EXE (30 Jan 90): This is the MicroSat decoding software by Bob McGwier, N4HY. It will decode the binary telemetry either in real-time or from a file. There is a test data file (testdata.raw) you can run to see how the program works. This is a self-extracting file, so copy it to your hard disk and then type TLMDC3 followed by a carriage return, and all the files will appear.

NK6K-TLM: This program by Harold Price, NK6K, will decode the ASCII data that you've captured on disk from Dove or and any of the other MicroSats. Source code is not included. This is a self-extracting file. Follow the same procedure as above: copy it to your hard disk and then type NK6K-TLM followed by a carriage return, and all the files will appear.

SIMPLE14.EXE: This program from Jeff Ward, GØ/K8KA, will decode the binary telemetry data that you've captured on disk from the new UoSAT satellites. Test data files are not included. This is a self-extracting file. Follow the same procedure as above: copy it to your hard disk and then type SIMPLE14 followed by a carriage return, and all the files will appear.

MBB33.EXE: Is the MBBIOS program you will need if you run TLMDC from a com port OTHER THAN COM1 or COM2. Read the TLMDC docs to learn whether you need to use this program. This is a self-extracting file.

LUSAT.BAS: This is a program that will decode the CW telemetry received from LUSAT. Follow the 'documentation' provided in the code.

WHATS-UP: This program by Joe Kasser, G3ZCZ, does not need the KISS mode. User customizable, automatic capture to disk, real-time and play back modes. Can also be used as a packet dumb terminal. You must set your TNC ''HEADERLINE ON'' option. Comes configured for DOVE but may be used on any of the MicroSats.

PACSAT EXPECTATIONS AND PREPARATIONS

By John Branegan GM4IHJ @ GB7SNE

8 Whitehills
Saline, Fife
Scotland KY12 9UJ.

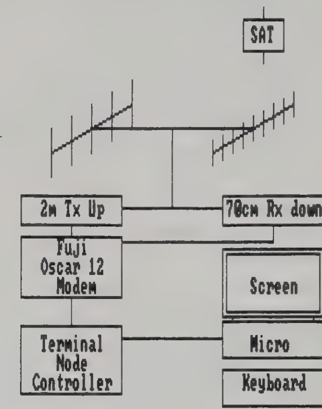


Fig. 1 — A simple PACSAT Station

Introduction

Of the six MicroSats launched into low Earth orbit on 22 January of this year three are fitted with store-and-forward, space packet facilities (PACSAT-OSCAR-16, LUSAT-OSCAR-19 & UoSAT-OSCAR-14). The satellite builders have given us, the satellite users, a marvelous opportunity for experimentation.

This article describes how one potential user is planning to be in a position to use this opportunity efficiently and effectively.

The Terrestrial Packet Radio Scene 1989/1990

Terrestrial packet radio networks have sprung up all over the world. Their local communications provisions are generally excellent, but there is an almost complete absence of facilities for rapid dissemination of International traffic. There is one link between the USA and Europe by means of the N4QQ-1 to GB7LDI and 4X1RU path, and only two or three West Coast stations interfacing to AsiaNet. The high frequency radio bands are already crowded with other popular transmission modes, while at vhf and uhf, long range terrestrial packet connections are extremely expensive to construct and suffer from all the problems of a single track railway/queuing system.

PACSAT Trials 1989

The first satellite carrying a packet radio package (Fuji-OSCAR-12) ceased to operate in 1989. Fuji-OSCAR-12 and UoSAT-OSCAR-11 have been used as store-and-forward message carriers. These first ever PACSATs were built as simple state of the art demonstrators. They have clearly proved the viability of low Earth orbit packet relay via satellite, but they were never intended to sustain even sporadic usage by international packet services.

PACSAT Expectations 1990

No one should imagine that the PACSATs now in orbit, and the Japanese built Fuji-OSCAR-20, (can you believe that number), will instantly solve all our packet problems. Indeed this author is concerned that if all these satellites operate effectively, the traffic loading generated by their success could overwhelm them, unless operating schedules are carefully coordinated. It would be wise therefore not to expect too much, too soon, from these birds, particularly if one considers that in some respects the launching is only the tip of the iceberg. The amount of terrestrial effort that will be needed by each local community is very considerable.

A Single Operator PACSAT Station 1990

The bare bones of the situation are revealed by Figure 1 and Table 1. Table 1 portrays a prediction of the complex timetable of satellite events which will face the would-be operator every day. Figure 1 shows the minimum hardware requirements of his or her station. Hidden in these bland illustrations is the fact that the operator will be required to deploy new techniques in a field, where up to now successful Radio Amateurs have been few and far between. Noting that in ten years of usage of Mode J analog, starting with satellite AMSAT-OSCAR-8J, through JAMSAT's Fuji-OSCAR-12 JA and, AMSAT-OSCAR-13J, GM4IHJ's log of callsigns worked worldwide reveals a meagre 180 different individual calls. No one should underestimate the difficulties attendant on 70cms downlink reception with its fierce Doppler shift and its unforgiving hardware requirements — make do and half good, are no good at uhf. Equally important, would-be PACSAT sta-

Table 1 A Timetable of One Day's In Range Packet Satellite Passes

PACSATs in range today - 3/8/89 . All AOS and LOS times are UTC.

AOS	PACSAT	LOS	AOS	PACSAT	LOS	AOS	PACSAT	LOS
0020	PO-18	0024	1352	FO-20	1406	1948	FO-20	2010
0032	WO-18	0032	1400	PO-18	1408	2029	PO-18	2043
0045	FO-20	0101	1404	LO-19	1412	2032	LO-19	2046
0724	PO-18	0724	1412	WO-18	1420	2040	WO-18	2055
0726	LO-19	0726	1444	UO-14	1450	2112	UO-14	2126
0733	WO-18	0737	1540	PO-18	1544	2150	FO-20	2211
0804	UO-14	0811	1543	LO-19	1547	2209	PO-18	2223
0900	PO-18	0912	1548	FO-20	1608	2213	LO-19	2228
0904	LO-19	0916	1551	WO-18	1555	2222	WO-18	2235
0911	WO-18	0925	1622	UO-14	1628	2254	UO-14	2307
0943	UO-14	0957	1716	PO-18	1722	2351	FO-20	2351
1040	PO-18	1054	1719	LO-19	1728	2354	PO-18	2354
1044	LO-19	1058	1727	WO-18	1735			
1051	WO-18	1105	1747	FO-20	1810			
1123	UO-14	1137	1757	UO-14	1807			
1220	PO-18	1232	1851	PO-18	1903			
1224	LO-19	1236	1855	LO-19	1907			
1232	WO-18	1244	1903	WO-18	1915			
1303	UO-14	1316	1933	UO-14	1946	End		

Table 2. PACSAT Parade begins at 1540 ut on 3/8/89

	PO-18 AZ	EL	LU-19 AZ	EL	WO-18 AZ	EL	UO-14 AZ	EL	FO-20 AZ	EL
1540	14	1	:	:	:	:	:	:	:	:
1542	357	2	:	:	:	:	:	:	:	:
1544	340	1	13	1	:	:	:	:	:	:
1546	:	:	356	2	:	:	:	:	:	:
1548	:	:	340	1	:	:	:	:	201	0
1550	:	:	:	:	:	:	:	:	195	6
1552	:	:	:	:	13	1	:	:	188	11
1554	:	:	:	:	357	2	:	:	177	18
1556	:	:	:	:	340	1	:	:	162	24
1558	:	:	:	:	:	:	:	:	142	27
1600	:	:	:	:	:	:	:	:	123	26
1602	:	:	:	:	:	:	:	:	105	21
1604	:	:	:	:	:	:	:	:	92	15
1606	:	:	:	:	:	:	:	:	83	9
1608	:	:	:	:	:	:	:	:	77	3
1610	:	:	:	:	:	:	:	:	:	:

tion builders should be aware that while the Fuji-OSCAR-12 1200 bps modem is correct for the initial operating phases of PACSAT-OSCAR-16, WEBERSAT-OSCAR-18 and LUSAT-OSCAR-19, these spacecraft may switch at a later date to 4800 bps operation, and, UoSAT-OSCAR-14 and 15 are using 9600 bps right from the start of their operations.

Single Operator Procedures

The ground station will resemble a mutated terrestrial packet station, attached to a typical Mode J satellite station as shown in Figure 1. Operating procedures will revolve around station software answering the following questions:

a. It is time HHMM, what is the next useful PACSAT pass? Are other PACSATs present consecutively or concurrently? Table 1 and Table 2 show how software can provide answers to these questions and, other supplementary questions such as, is this pass near to or far from my station?

b. Where has the PACSAT I propose to use just been, and where is it going next? Table 3 shows a simple graphic presentation which can be used to rapidly review past, present and future orbital tracks.

c. How do I get accurate real time or predicted tracking data for my chosen satellite pass? Can I have accurate minute by minute Doppler shift data? Table 4 shows how this data might be presented to a manually operated station, or be used to feed autotracking antennas.

Tables 1 to 4 are derived from GM4IHJ software designed to allow simulation and exploration of operator software needs. Test runs on Fuji-OSCAR-12 and UoSAT-OSCAR-11 suggest the hardware and software services outlined here are an absolute minimum.

Multi User Gateway Stations

Most would be users of space packet systems will have no experience of satellite operating. There is therefore no chance that they will be able to build or use simple personal PACSAT stations. This does not mean, however, that they will be excluded from PACSATs. Many years ago Joe Kasser, G3ZCZ, proposed the gateway concept whereby a complex ground station facility can provide satellite services to operators with no satellite expertise[1]. In recent years this has culminated in the introduction of several gateways which provide transparent user-friendly connection between terrestrial vhf repeater users, and satellite facilities such as AMSAT-OSCAR-13. Figure 2 shows a typical schematic of this type of gateway facility.

If space packet usage is to become commonplace, gateway facilities will need to be established with simple throughput direct from terrestrial packet networks connecting to the gateways and thence to and from the space packet satellites. Almost duplicating terrestrial bulletin boards, these packet gateways would employ local store-and-forward facilities, such that the message originator simply files his traffic with the gateway. The gateway then automatically forwards the traffic to appropriate PACSATs, at a convenient moment, perhaps some time after receipt. Incoming foreign traffic follows the reverse path, with the gateway accessing passing PACSATs automatically and calling for download of any messages addressed to its nominated users. This traffic is then held on the gateway bulletin board until

Table 3 — Orbit begins at ascending EQX for PACSAT-OSCAR on 3.8.89.

Table 4. Example of Predicted Tracking and Doppler Data WEBERSAT-OSCAR 18 on 3.8.89

UTC	AZ	EL	Lat	Long	Dopshift KHz
1903	104	1	43	327	na
1904	99	4	46	328	+ 7.8
1905	92	8	49	330	+ 7.2
1906	84	11	53	332	+ 6.3
1907	74	14	56	333	+ 5.1
1908	62	17	60	336	+ 3.5
1909	47	18	63	338	+ 1.4
1910	33	17	67	342	- 1.0
1911	20	15	70	346	- 3.1
1912	10	12	73	352	- 4.9
1913	2	8	76	0	- 6.2
1914	355	5	78	12	- 7.1
1915	350	2	80	29	- 7.7
1916	346	-1	81	51	na

withdrawn by the intended recipient, or, it is reverse forwarded to the recipient directly, via terrestrial packet links, see Figure 3.

The above scenario will not suddenly appear in full working order. In the first years of space packet usage, say up to at least 1995, it is probable that gateways which do appear will be far less sophisticated. Indeed we could see several classes of gateway design:

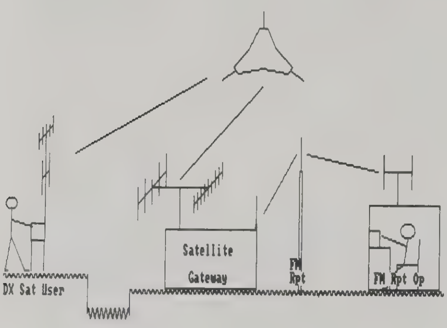


Fig. 2 — Terrestrial gateway for VHF voice to and from the satellite.

Type "A" Gateway. A relatively simple node accessible via terrestrial packet links, but with only "Use it, when you call it", real time assistance, where the individual caller accesses the gateway and takes the packet satellites as they come.

Type "B", an Indirect Access Gateway. An improved gateway which does not allow direct user access to PACSATs. All incoming and outgoing traffic for and from space is routed through a bulletin board which the gateway accesses as and when suitable despatch and receipt opportunities are offered.

Examples of these stations include that currently operated by WB6GFJ[2], DB2OS, GB3UP, ZS6SAT and the first Italian DCE station, IK2KBD, was successfully put into operation during UoSAT-OSCAR-11's orbit 29947 on the 10th October 1989, when I2KBD was able to command the spacecraft and forward messages to GØ/K8KO in Surrey using the DCE experiment. A typical message sent to your editor is shown with full routing information in Figure 4.

(Editor's note: I have experimented with the link by sending a message to G3ZCZ @ N6IIU in the format desribed by WB6GFJ in his article[2]. The message was passed to WB6GFJ and subsequently uplinked to UoSAT-OSCAR-11 and received at GB3UP. From there it went by terrestrial vhf/uhf links to GB7LDI. GB7LDI forwarded the message to 4X1RU on 20M, who passed it on to N4QQ-1, also on 20M. N4QQ-1 bounced it to N4QQ on 2M from where I picked it up. Fascinating.)

Type "C", a Universal Gateway. A model which many users seem to expect, but are unlikely to get, at least not in the early days, and perhaps not at all. This gateway would provide both local store, forward, receive and reverse forward facilities for users uninterested in how it works, who just want results, and, it would also provide, completely transparent user access from terrestrial packet links to the PACSATs for both receipt and despatch of traffic. One can envisage this type of gateway being available on a restricted basis to the operators of a large international traffic network, or emergency service.

There are lots of questions which it is probably foolish to ask until we have some hard experience of the capabilities of the PACSATs. Whatever way we go, it is clear that we need development of software for both single user facilities and, gateways. This software will be a mutated version of present packet radio communications AX25 source code and, operational software of the type described above.

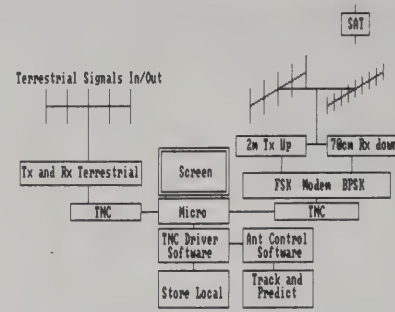


Fig. 3 — A packet satellite gateway.

Pre Launch, Construction and Experiments

It should be clear from the above examples that a great deal of individual and group effort at a local and a national level will be necessary, if we are to get useful Earth to space, PACSAT access facilities.

At GM4IHJ the first task has been to develop software answers to the ground station operational data requirements. The prototype of this software is now running on an IBM PS/2 Model 50 micro in both interpreted IBM Advanced Basic, and compiled Turbo Basic. At this early stage, GM4IHJ has no plans to publish this software. It is merely intended as a test and simulation model which GM4IHJ would be happy to discuss with all genuinely interested parties working on similar, or, dissimilar lines.

References

[1] "Is This the Future," Joe Kasser, G3ZCZ, *The AMSAT Newsletter*, Volume 10 Number 3, September 1978.

[2] UoSAT-OSCAR-11 Gateway Station On-line, Ross Forbes, WB6GFJ, *The AMSAT Journal*, Volume 12 Number 2, August 1989.

Figure 4. Example of a message to your editor received via the DCE routing.

```
Date: 04 Oct 89 04:20:40 Z
From: WB6GFJ@N6IIU
To: G3ZCZ
Subject: DCE Message For You

R:891004/0420z 24086@N4QQ   [Silver Spring,Md]  Z:20901
R:891004/0406z 57686@W3IWI  [Balto/Wash MD/DC/VA/DE] Z:21029
R:891004/0341z @:N6VV.*NOCAL.CA.USA.NA Pleasant Hill, CA *:18717 Z:94523
R:891004/0328z @:W6PW San Francisco, CA *:7566 Z:94101
R:891003/1925L @:N6IIU Palo Alto, CA *:3416 Z:94301

SP  G3ZCZ  @ N4QQ   < Z21GH
Amsat Journal
R:890923/1752z 2643@ZS6IT  [SA AMSAT DCE SATELLITE GATEWAY  RSA]
R:890918/0655z 11936@ZS6SAT [RSA]
From: Z21GH@ZS6SAT
To: G3ZCZ@N4QQ
Subject: Amsat Journal
```

```
Hello Joe,

I have just received the first edition of The AMSAT Journal
and I am very impressed with the standard and format. I am
also taking the opportunity to test the worldwide packet
network and your invitation for comments on the publication.

I am life member No. 1953 and I would like to thank you for
the new style information sheet. The format is great as there
is a lot of information that is not dated. There is no need
for orbital elements etc., as we can pick these up from our
local PBBS now. Your Journal dated May 1989 arrived in September,
so there is no point (in my opinion) in publishing historic data.

I get the up to date information I need from Hans and the
fellows at SA AMSAT. I would suggest that the Journal be used
as a reference source. The article's on both the MicroSat's
and the packet BBS's are excellent. I look forward to future
AMSAT Journals with anticipation.

You can reach me at Z21GH @ ZS6SAT

73 De Des, Harare, Zimbabwe.
```

HINTS ON USING THE AMSAT-OSCAR-13 MODE S TRANSPONDER

By William D. McCaa, KØRZ

P. O. Box 3214
Boulder, CO 80307

Have you forgotten that AMSAT-OSCAR-13 carries more than one transponder. Mode B is not the only way to communicate through this bird. Mode S is alive and well. This article gives you some ideas about Mode S and how to use it.

Equipment requirements for Mode S

Uplink:

If you are successfully operating Mode B on AMSAT-OSCAR-13, you have all the equipment necessary for the uplink to the Mode S transponder. There is nothing special about the Mode S transponder, 1000 Watts ERP is more than adequate, and will produce a good SSB downlink signal.

Downlink:

Receiving in the 13-cm band is exciting and educational. All of the receiving equipment is available through commercial manufacturers. A small dish about one meter in diameter or long loop Yagi will provide all the antenna needed. If you use a loop Yagi, make sure it is cut for 2400 MHz, as a loop Yagi for 2304 MHz. will not work. The converter must have crystal stability and the preamp/converter system should have a noise figure of less than 3 dB.

Performance:

The uplink/downlink system described above should provide you with a downlink signal about 10 dB above the background noise. If a greater downlink signal is desired, you should improve the receive antenna size and reduce the system noise figure. Uplink power should be increased as a last resort and should be kept below 3000 Watts ERP.

Transponder Frequencies

On orbit 1199 of AMSAT-OSCAR-13 on 7 January 1990, I measured the Mode S transponder frequencies as listed in Table 1. All frequencies have been corrected for Doppler shift, and should be within 1 kHz of actual.

Operating Notes

When the Mode S transponder is active and the Mode B transmitter is off, a 1kW ERP uplink signal will produce an excellent downlink signal on Mode S. A power level greater than 3kW ERP will pump the Mode S downlink signal. This is a common problem during simultaneous Mode B and Mode S operation.

The Mode B uplink band is available whenever the Mode S transponder is operating. The Mode B transmitter need not be enabled for the Mode B uplink to be active. The Mode B uplink is about 3 dB less sensitive than the Mode S uplink.

When the Mode S Beacon is operating and provided the Mode B receiver is active (not during Mode L) a signal can be passed by the Mode S transponder but with about 17 dB less sensitivity on the Mode S uplink and 20 dB less sensitivity on the Mode B uplink.

The Mode S transponder is non-inverting. An uplink signal on USB will downlink on USB from the Mode S

Table 1 Mode S Passband Frequencies.

Passband	Mode S Down	Mode S Up	Mode S&B Up	Mode B Down
Lower Limit	2400.711	435.603	435.480	145.917
Center	2400.729	435.621	435.498	145.899
Upper Limit	2400.747	435.639	435.516	145.881
Beacon	2400.664			

Note: all frequencies are in MHz.

Table 2 AMSAT-OSCAR 13 MODE S STATION LIST

Sources: KØRZ, W4FJ, DB2OS, JR1WZI

CALL	Name Beacon S+N/N	RST @ QSO SENT/RECV	Uplink equipment power/ant	Downlink equip ant/pre amp	NF
DK2ZF	Rolf		No longer QRV	1.2 mtr dish	10
DF8NL	Hardy	52/52	?	2X20 Yagi	--
DF5DP	Bert	58/57	50W, 2X20 Yagi	Yagi 20 dBd	10
DL9GU	Ed	519/559	100W, 4X22 Yagi	1.2 mtr dish	--
DJ9PC	Peter		?	?	
G2BFO	David	56/57	15W, 4X19 Yagi	1.2 mtr dish,	14
G4JY	Art		?	?	
GW3XYW	Stuart	229/549	50W, 16 turn helix	6 mtr dish	20
IN3HER	Raimund	529/559	100W, 2X20 Yagi	1.5 meter dish	10
I6PNN	Amato	56/56	80W, 10 turn helix	2 mtr dish	--
I7UGO	Hugo	57/57	50W, 4X20 Yagi	2 mtr dish	--
I7FKO	Frank	529/559	?	?	
I7LIT	Rino		?	?	
JA1AUH	---		?	52 el loop Yagi	10
JA1SYK	Hiro	57/57	100W, 4X21 Yagi	1.2 mtr dish	--
JA1UHY	Hisa		100W, 2X25 Yagi	2 mtr dish, 0.9	20
JH1PEF	---		?W, 22el X-Yagi	1.8 mtr dish	--
JR1WZI	Ken	57/57	50W, 4X15 Yagi	1.5 mtr dish, 3	18
JA3GCT	---		?W, 23 turn helix	2X23 turn helix	--
JR4AEP	---		?	?	
JA4BLC	Row		?W, 6 mtr dish	6 mtr dish	--
JR4BRS	Toshe	53/59	100W, 4X21 Yagi	4 mtr dish,	20
JA6AUX/1	Masa	57/57	100W, 2X12 Yagi	1X36 loop Yagi	--
JA7EC	Shoji	569/579	10W, 2X20 Yagi	2 mtr dish	--
JH7JKW	Nikio		?W, 4 mtr dish	4 mtr dish	
JA8PL	---		?W, 20 turn helix	3.6 mtr dish	--
JA8ERE	---		?	2.0 mtr dish	--
K8TL	Tom	56/56	50W, 2X8 Yagi	4 ft dish	--
KØKE	Eric	519/339	40W, 4X19 Yagi	12 ft dish, 0.9	8
KØRZ	Bill	---/---	30W, 4X15 Yagi	4 ft dish, 0.9	18 *
ON4DY	Bob		?	?	
ON6UG	Freddy	56/56	50W, 2 mtr dish	2 mtr dish, GaAs	15
VE2LI	George	57/57	100W,1X40CX KLM	4 ft dish, GaAs	--
VE4MA	Barry	539/569	100W, 8X19 Yagi	12 ft dish, 1	23 *
W1NU	Vick	57/57	100W, 1X40CX KLM	2X45 loop Yagi	--
WA3ETD	John		?	4 ft dish	6
W4FJ	Ted		80W 10 turn helix	1X45 loop Yagi	--
W4ODW	Gene	55/44	600W, 4X19 Yagi	2X60 loop Yagi	--
WB5LUA	Al	57/57	100W, 10 turn helix	4 ft dish, 0.8	10
WB7ABP	Lynn	519/599	25W, 2X12 turn helix	10 ft dish	25
WBØQIY	Doug	56/55	100W, 1X40CX KLM	4 ft dish, 0.8	6

* First known Mode S QSO 17 Sept., 1988 @ 2025 UTC

transponder, while it will downlink on LSB on the Mode B transponder.

I have had many good cross Mode S to Mode B QSO's by using the Mode B uplink band with LSB and working Mode B stations. I find this method far more satisfactory than fighting the Mode B QRM on Mode S.

If you read John Fail's DX column, you may get the impression that all the DX activity is on Mode B. Well, while much of the DX is on Mode B, there is a considerable amount on Mode S as well as shown in Table 2.

AMSAT OSCAR-13 Transponder Schedule

(Through 9 May 1990)

Mode-B	:	MA 000 to MA 165
Mode-JL	:	MA 165 to MA 195
Mode-S	:	MA 195 to MA 200
Mode-BS	:	MA 200 to MA 205
Mode-B	:	MA 205 to MA 256
Omnis	:	MA 240 to MA 060

Note that from 21 February 1990 to 21 March 1990 the spacecraft will experience Solar eclipses. The length of the eclipses vary between 12 and 89 minutes.

The spacecraft will operate on a reduced schedule to conserve battery power. As such there will be an OFF period from MA 20 to MA 90, and the Mode B beacon will be operational during the scheduled Mode S time from MA 195 to MA 200.

Spacecraft attitude on 3 February 1990 was ALON=207.1/ALAT=+2.9, which results in an optimum Squint angle around MA 200.

The President's Editorial

(Continued from page 3)

ly there are only a handful of individuals who are in a position to produce such information.

The second area is practical information of an operational nature. Topics covered in this area include ground station considerations, satellite tracking topics (including Keplerian elements), DX operating news, equipment reviews and information of a practical application to anyone who wishes to operate via the satellites. As can be imagined the pool of individuals who are in a position to author articles in this area is considerably larger than the previous group.

The third area is the news and organizational material. The members need to know what is going on within their organization. The publication should serve as the mechanism to fulfill this need. Volunteer recognition, issues which affect the organization, member activities and reports from the various officers are all

topics which fall into this area. Here again, there exists a reasonably large base of people who could write such material and submit it for publication.

The final factor to consider in the publications issue is the financial resources available to support the publication activity. As part of the budget process a certain percentage of the annual dues taken in by the organization are budgeted for publications expenses. There is a very clear balance which must be struck between all of the expenses incurred by the organization. Publication expenses represent only one element of our overall financial need. Satellite development costs, launch expenses, overhead expenses necessary to maintain the organization and general operating expenses enter into our financial picture.

In the final analysis there are three factors which must be considered in producing a quality publication: manpower, available material and money. The role of AMSAT management in setting publication policy is to define our available resources and optimize their output in order to provide you, the member, with the highest quality publication possible.

There are a number of questions which must be answered once the resources to be applied to publications are defined. They include: what production cycle will the publication be produced in, what size will the individual editions be and what type of format will be used in publishing the periodical. These are all important questions that must be studied carefully.

The first question, the production cycle, is answered by evaluating all three of the resources involved. Production cycle may well be one of the most debated topics in the area of publications. Non-profit groups such as AMSAT follow a whole spectrum of production schedules with their publications. While a monthly publication is desirable in many ways, given the manner in which AMSAT produces its publications coupled with the financial constraints we face, it is simply not realistic to expect a volunteer editor who is working in his spare time with material provided by volunteer authors to be able to maintain a monthly production cycle and consistently produce a quality periodical.

The second and third questions, publication size and format, are answered in large measure by the financial resources available from within our budget as well as by our ability to garner income from placing advertising within the pages of the given publication. While we have been modestly successful in generating income

(Continued on page 28)

Six for the Price of One . . .

(Continued from page 1)

and an image size 1000 km square. The image is 386 pixels X 244 pixels with 8-bits of gray scale per pixel. Images will be transmitted on the UoSAT-E downlink to all Radio Amateurs, probably using AX.25 packet radio (generated by yet another onboard computer, the CMOS Z80). Further details of the UoSAT spacecraft are to be published elsewhere.

The past two weeks were also used to find the sources of problems observed during thermal vacuum tests. Two or three were traced to wiring errors and/or pin failures in the 1200-connection wiring harnesses. These were corrected and the harnesses reverified. The temperature sensitivity of the navigation magnetometer was also located, after several days' piecemeal thermal testing of the "navmag" and associated subsystems.

The mandatory flight-acceptance vibration tests were conducted this week back at the Royal Aerospace Establishment, and both satellites passed without hitch. (These tests are much less severe than the "qualification level" tests which were conducted on Engineering Model satellites this summer.) UoSAT-D and E are now in the clean room at the University of Surrey, where they will undergo nearly two months of operational tests, and provide testing grounds for the PACSAT and experimental software which is now under development at Surrey. — *Jeff, GØ/K8KA*

October 30, 1989 Situation Report

As Jeff Ward from UoSAT mentioned in an earlier note, we are all making use of this reprieve (errr, Uhhh, I meant delay) from the November launch to work on the flight software and finding and fixing anomalies in the hardware. Harold Price, NK6K, and Skip Hansen, WA6YMH, from Quadron Service Corp. have been doing the development of the kernel, the AX.25, and the serial device drivers for all of the MicroSats as well as for the UOSAT-D PCE. Quadron was kind enough to donate the use of their proprietary product, the QCF kernel, under which all software on the main MicroSat CPU runs (DOVE and LUSAT have microcontrollers in the TSFR modules controlling these functions). Quadron also has donated many hours of Harold and Skip's time towards this project, including allowing Harold to spend over a week in the Boulder labs in preparation for and participating in the thermal-vacuum test.

The weekend of October 13, Harold, AMSAT President Doug Loughmiller, KO5I, and I (N4HY) flew into the Boulder area for another major push to finish the initial software load. Jan King, W3GEY, Jim White, WDØE, Greg Hines, WDØM and Jeff Zerr represented local Boulder troops during the week-long proceedings. What was supposed to be a major software push, as usual, turned into a "what's wrong with the hardware now!" as two areas of vital sensory data were out of bounds in all spacecraft. We lost 512K of memory in AMSAT-NA's MicroSat, an error by yours truly blew a wire in the Weber State Power Module.

As if that wasn't enough, the ground station supplied wouldn't copy anything from any spacecraft except DOVE, the MFJ TNC (multimode 1278) didn't operate as the earlier TNC's that all present owned, etc, etc. After almost an entire day was wasted, the cockpit crew finally realized that the notch filter (can you believe a notch filter on a uhf radio!) was engaged. After turning off the notch filter, we managed to never lose another packet during the entire week I was there, so far as I can remember. Just thought I would let you know, we do stupid stuff as well as anyone, if not better.

Harold had brought the latest updates to the kernel, and he and I installed the final flight ROMS containing the now vastly superior bootloader, MBL, written by Hugh Pett, VE3FLL. The latest groundstation code for using MBL was exercised and we pronounced these ROMS as fit for flight. Harold and Skip had written a special version of the AX.25/HDLC handler that would allow 38.4 kbit/sec asynchronous data to be transmitted as well. This was in order to talk to the DOVE module, which will require moderate bit rates to transfer intelligible speech in digital samples to the 68HC11 microcontroller in DOVE. I brought the power module control algorithms, and included in this was control over the power output of the transmitters in order to achieve maximum power output while keeping a positive power budget. Other control aspects were included in this initial module after the kernel and the control modules were taught how to talk to each other. The control ports on all spacecraft but DOVE were tested.

Hours of telemetry were gathered from the spacecraft, and the battery charge control algorithms were exercised successfully after additional 'development time'. Also Harold and Chris Williams, WA3PSD, from CAST at Weber State brought the latest camera control software for the Weber State module. After we got software running on the birds that dumped telemetry in flight format, we noticed that, just as in the thermal vacuum tests, the current readings made no sense.

> Spot-2 is an Earth resources satellite with a high resolution camera. The MicroSat's include two packet radio satellites, PACSAT and LUSAT, a camera and experiment satellite WEBERSAT, and a voice encoder educational satellite called DOVE (Digital Orbiting Voice Encoder). PACSAT is sponsored by AMSAT- NA and TAPR. LUSAT is sponsored by AMSAT Argentina. WEBERSAT is sponsored by the Center for Aerospace Sciences and Technology at Weber State College in Utah. DOVE is sponsored by Torres "Junior" De Castro, PY2BJO, and Brazil AMSAT. The MicroSats themselves were described in *The AMSAT Journal* earlier.[1] All spacecraft had contributions made to them by the ARRL and its laboratory staff. The UoSAT satellites were built by the University of Surrey and are continuing in the tradition of UoSAT-OSCARs-9 and 11.

It was discovered that a capacitor, intended to smooth the analog signal was a couple of orders of magnitude too large, and the signal would have to be present on the bus for close to a second before it could be read. After determining a better value, these capacitors were replaced in all of the modules, and the current sensors behaved normally. Then it was noticed by yours truly that the voltages read in the power module were oscillating at least 25% of the entire range. The analog signal was dropped on the sensor wire and it was discovered that we had a generic problem in this sensor setup, in that all spacecraft that had this circuit, oscillated at about 70 kHz. The sensors involved in this problem were even more important than the current sensors we had just fixed in that they measured all of the important voltages in the spacecraft. The final op-amp in the circuit was oscillating and upon applying a small capacitance to the op-amp to form a lowpass filter or leaky integrator, the oscillation disappeared and the voltages readings became the very accurate readings we had seen when the power module was NOT hooked up to the rest of the bus. Jeff Zerr also found a shorted bypass capacitor that was connected to the bank selection circuitry for the mass memory and removed the short.

Final hardware status: All spacecraft have had their hardware checked out and all are functioning properly now. All spacecraft have a full complement of memory that passes the Harold Price

[1] *This and all other footnotes appear at the end of the article.*

Microsat Telemetry (TLM) Equations

By Jan King W3GEY

Spacecraft: PACSAT-1:

Date: 1/7/90

Equations are in the form: Y = A*N^2 + B*N + C

where: N = Telemetry Count (00 - FF)
A, B, C = Equation Coefficients
Y = Result (In Specified Units)

HEX	Descripion:	C:	B:	A:	Units:
		cccccccccc	bbbbbbbbbb	aaaaaaaaaa	uuuuuu
0	Rx D DISC:	+9.202	-0.08990	0.000	kHz
1	Rx D S meter:	+0.000	+1.000	0.000	Counts
2	Rx C DISC:	+9.179	-0.09277	0.000	kHz
3	Rx C S meter:	+0.000	+1.000	0.000	Counts
4	Rx B DISC:	+9.837	-0.08838	0.000	kHz
5	Rx B S meter:	+0.000	+1.000	0.000	Counts
6	Rx A DISC:	+9.779	-0.09144	0.000	kHz
7	Rx A S meter:	+0.000	+1.000	0.000	Counts
8	Rx E/F DISC:	+10.817	-0.09911	0.000	kHz
9	Rx E/F S meter:	+0.000	+1.000	0.000	Counts
A	+5 Volt Bus:	+0.000	+0.0305	0.000	Volts
B	+5V Rx Current:	+0.000	+0.000250	0.000	Amps
C	+2.5V VREF:	+0.000	+0.0108	0.000	Volts
D	8.5V BUS:	+0.000	+0.0391	0.000	Volts
E	IR Detector:	+0.000	+1.000	0.000	Counts
F	LO Monitor I:	+0.000	+0.000037	0.000	Amps
10	+10V Bus:	+0.000	+0.0500	0.000	Volts
11	GASFET Bias I:	+0.000	+0.000026	0.000	Amps
12	Ground REF:	+0.000	+0.0100	0.000	Volts
13	+Z Array V:	+0.000	+0.1023	0.000	Volts
14	Rx Temp:	+101.05	-0.6051	0.000	Deg. C
15	+X (RX) temp:	+101.05	-0.6051	0.000	Deg. C
16	Bat 1 V:	+1.8225	-0.0038046	0.000	Volts
17	Bat 2 V:	+1.9418	-0.0046890	0.000	Volts
18	Bat 3 V:	+1.8699	-0.0041641	0.000	Volts
19	Bat 4 V:	+1.7403	-0.0032880	0.000	Volts
1A	Bat 5 V:	+1.8792	-0.0042492	0.000	Volts
1B	Bat 6 V:	+2.0499	-0.0054532	0.000	Volts
1C	Bat 7 V:	+1.9062	-0.0045331	0.000	Volts
1D	Bat 8 V:	+1.7536	-0.0033192	0.000	Volts
1E	Array V:	+8.055	+0.06790	0.000	Volts
1F	+5V Bus:	+2.035	+0.0312	0.000	Volts
20	+8.5V Bus:	+5.464	+0.0184	0.000	Volts
21	+10V Bus:	+7.650	+0.0250	0.000	Volts
22	BCR Set Point:	-6.1130	+1.1270	0.000	Counts
23	BCR Load Cur:	-0.0477	+0.00767	0.000	Amps
24	+8.5V Bus Cur:	-0.00179	+.000894	0.000	Amps
25	+5V Bus Cur:	-0.00104	+0.00406	0.000	Amps
26	-X Array Cur:	-0.00995	+0.00243	0.000	Amps
27	+X Array Cur:	-0.02370	+0.00254	0.000	Amps
28	-Y Array Cur:	-0.02220	+0.00273	0.000	Amps
29	+Y Array Cur:	-0.01810	+0.00259	0.000	Amps
2A	-Z Array Cur:	-0.02230	+0.00221	0.000	Amps
2B	+Z Array Cur:	-0.02000	+0.00232	0.000	Amps
2C	Ext Power Cur:	-0.02000	+0.00250	0.000	Amps
2D	BCR Input Cur:	-0.02345	+0.00355	0.000	Amps
2E	BCR Output Cur:	+0.00869	+0.00303	0.000	Amps
2F	Bat 1 Temp:	+101.05	-0.6051	0.000	Deg. C
30	Bat 2 Temp:	+101.05	-0.6051	0.000	Deg. C
31	Baseplt Temp:	+101.05	-0.6051	0.000	Deg. C
32	PSK TX RF Out:	-0.0291	+0.00361	+0.0000869	Watts
33	RC PSK TX Out:	+0.0055	+0.00172	+0.0001180	Watts
34	PSK TX HPA Temp	+101.05	-0.6051	0.000	Deg. C
35	+Y Array Temp:	+101.05	-0.6051	0.000	Deg. C
36	RC PSK HPA Temp	+101.05	-0.6051	0.000	Deg. C
37	RC PSK BP Temp:	+101.05	-0.6051	0.000	Deg. C
38	+Z Array Temp:	+101.05	-0.6051	0.000	Deg. C
3A	S band TX Out:	-0.0088	+0.00435	0.000	Watts
39	S band HPA Temp	0.000	+1.000	0.000	Counts

ADC Equations: V = 0.01028 N - 0.02055
N = 97.31 V +2.000

Spacecraft: LUSAT-1:

Date: 1/7/90

Equations are in the form: Y = A*N^2 + B*N + C

where: N = Telemetry Count (00 - FF)
A, B, C = Equation Coefficients
Y = Result (In Specified Units)

HEX	Descripion: Units:		C:	B:	A:
		cccccccccc	bbbbbbbb	aaaaaaaa	uuuuuu
0	Rx D DISC:	+9.802	-0.08779	0.000	kHz
1	Rx D S meter:	+0.000	+1.000	0.000	Counts
2	Rx C DISC:	+8.429	-0.09102	0.000	kHz
3	Rx C S meter:	+0.000	+1.000	0.000	Counts
4	Rx B DISC:	+9.291	-0.08317	0.000	kHz
5	Rx B S meter:	+0.000	+1.000	0.000	Counts
6	Rx A DISC:	+9.752	-0.08310	0.000	kHz
7	Rx A S meter:	+0.000	+1.000	0.000	Counts
8	Rx E/F DISC:	+10.110	-0.08610	0.000	kHz
9	Rx E/F S meter:	+0.000	+1.000	0.000	Counts
A	+5 Volt Bus:	+0.000	+0.0305	0.000	Volts
B	+5V Rx Current:	+0.000	+0.000250	0.000	Amps
C	+2.5V VREF:	+0.000	+0.0108	0.000	Volts
D	8.5V BUS:	+0.000	+0.0391	0.000	Volts
E	IR Detector:	+0.000	+1.000	0.000	Counts
F	LO Monitor I:	+0.000	+0.000037	0.000	Amps
10	+10V Bus:	+0.000	+0.0508	0.000	Volts
11	GASFET Bias I:	+0.000	+0.000026	0.000	Amps
12	Ground REF:	+0.000	+0.0100	0.000	Volts
13	+Z Array V:	+0.000	+0.1023	0.000	Volts
14	Rx Temp:	+93.24	-0.5609	0.000	Deg. C
15	+X (RX) Temp:	+93.24	-0.5609	0.000	Deg. C
16	Bat 1 V:	+1.7343	-0.0029740	0.000	Volts
17	Bat 2 V:	+1.7512	-0.0032113	0.000	Volts
18	Bat 3 V:	+1.7790	-0.0034038	0.000	Volts
19	Bat 4 V:	+1.7286	-0.0030036	0.000	Volts
1A	Bat 5 V:	+1.8114	-0.0036960	0.000	Volts
1B	Bat 6 V:	+1.7547	-0.0032712	0.000	Volts
1C	Bat 7 V:	+1.7151	-0.0030739	0.000	Volts
1D	Bat 8 V:	+1.6846	-0.0028534	0.000	Volts
1E	Array V:	+8.100	+0.06790	0.000	Volts
1F	+5V Bus:	+2.035	+0.0312	0.000	Volts
20	+8.5V Bus:	+5.614	+0.0184	0.000	Volts
21	+10V Bus:	+7.650	+0.0250	0.000	Volts
22	BCR Set Point:	+3.7928	+1.0616	0.000	Counts
23	BCR Load Cur:	-0.0244	+0.00628	0.000	Amps
24	+8.5V Bus Cur:	+0.00412	+0.000773	0.000	Amps
25	+5V Bus Cur:	+0.02461	+0.00438	0.000	Amps
27	+X Array Cur:	-0.01614	+0.00232	0.000	Amps
26	-X Array Cur:	-0.01158	+0.00238	0.000	Amps
28	-Y Array Cur:	+0.00278	+0.00206	0.000	Amps
29	+Y Array Cur:	+0.00136	+0.00218	0.000	Amps
2A	-Z Array Cur:	+0.00370	+0.00209	0.000	Amps
2B	+Z Array Cur:	-0.00793	+0.00216	0.000	Amps
2C	Ext Power Cur:	-0.02000	+0.00250	0.000	Amps
2D	BCR Input Cur:	-0.00901	+0.00283	0.000	Amps
2E	BCR Output Cur:	+0.00663	+0.00344	0.000	Amps
2F	Bat 1 Temp:	+93.24	-0.5609	0.000	Deg. C
30	Bat 2 Temp:	+93.24	-0.5609	0.000	Deg. C
31	Baseplt Temp:	+93.24	-0.5609	0.000	Deg. C
32	PSK TX RF Out:	+0.1059	+0.00095	+0.0000834	Watts
33	RC PSK TX Out:	+0.0178	+0.00135	+0.0000833	Watts
34	PSK TX HPA Temp	+93.24	-0.5609	0.000	Deg. C
35	+Y Array Temp:	+93.24	-0.5609	0.000	Deg. C
36	RC PSK HPA Temp	+93.24	-0.5609	0.000	Deg. C
37	RC PSK BP Temp:	+93.24	-0.5609	0.000	Deg. C
38	+Z Array Temp:	+93.24	-0.5609	0.000	Deg. C
39	LU Bcn Temp A:	+93.24	-0.5609	0.000	Deg. C
3A	LU Bcn Temp D:	+93.24	-0.5609	0.000	Deg. C
3B	Coax Rly Stat:	+0.000	+1.0000	0.000	Counts
3C	Coax Rly Stat:	+0.000	+1.0000	0.000	Counts

ADC Equations: V = 0.00953 N
N = 104.94 V

chamber of horrors memory test. We will be flying 8 Megabytes of memory per spacecraft and barring in-orbit failures, we will have 32 Megabytes of memory in orbit in four boxes that are 8 inches by 8 inches by a little over an inch. Each box has three circuit boards in it, main CPU, high speed bank switch memory, and slow speed mass memory (RAM DISK). The computer draws *just over a watt in its highest power consumption state.* Because the Quadron kernel takes advantage of the halt instruction in the V40, for a large part of each tenth second quantum, the CPU is asleep and drawing a measly 80mA at 5 Volts for 0.4 Watts. Thus the CPU has beat its power budget if the 'in space' HDLC aborts are not significantly more frequent than we are seeing on the ground. The AX.25/Serial drivers Harold and Skip have written, will gather and maintain statistics on these false starts to a packet. This will determine what the final power consumption of the CPU will in fact be. These CPU's, which were a real bear to get all up and running, are beautiful in their final configuration. The 'California group', of which you will be hearing more, just absolutely refused to give up and pushed through to perfection on the computers giving our high tech risky venture the expertise it needed.

The receivers are receiving and making good bits with signals weak as -110 dBm. How I wish that -100 dBm were the kind of signal we would be seeing. In reality, we are all pretty sure that the typical AMSAT-OSCAR-13 Mode J groundstation setup will be used and pound the thing with -80 dBm. Unlike AMSAT-OSCAR-13, however, where this overload pumps the AGC, there will be no major bad effects on the hardware, it will just be harder for the entry level guys, who want to run omnidirectional antennas to get into the receivers (FM and hard limiting on the uplink gives you the capture effect). A problem with the load port, which must only work once on the pad in Kourou, was successfully fixed by Tom Clark, W3IWI, who also suggested the fix applied to the

Microsat Telemetry (TLM) Equations

By Jan King W3GEY

Spacecraft: WEBER-1: Rev: 1
Date: 1/7/90

Equations are in the form: Y = A*N^2 + B*N + C

where: N = Telemetry Count (00 - FF)
A, B, C = Equation Coefficients
Y = Result (In Specified Units)

HEX	Descripion: Units:	C:	B:	A:	
		cccccccccc	bbbbbbbbbb	aaaaaaaaaa	uuuuuu
0	Rx D DISC:	+11.087	-0.08949	0.000	kHz
1	Rx D S meter:	+0.000	+1.000	0.000	Counts
2	Rx C DISC:	+10.322	-0.09448	0.000	kHz
3	Rx C S meter:	+0.000	+1.000	0.000	Counts
4	Rx B DISC:	+10.348	-0.09004	0.000	kHz
5	Rx B S meter:	+0.000	+1.000	0.000	Counts
6	Rx A DISC:	+11.387	-0.09535	0.000	kHz
7	Rx A S meter:	+0.000	+1.000	0.000	Counts
8	Rx E/F DISC:	+10.746	-0.09348	0.000	kHz
9	Rx E/F S meter:	+0.000	+1.000	0.000	Counts
A	+5 Volt Bus:	+0.000	+0.03523	0.000	Volts
B	+5V Rx Current:	+0.000	+0.000234	0.000	Amps
C	+2.5V VREF:	+0.000	+0.0133	0.000	Volts
D	8.5V BUS:	+0.000	+0.0524	0.000	Volts
E	IR Detector:	+0.000	+1.000	0.000	Counts
F	LO Monitor I:	+0.000	+0.000033	0.000	Amps
10	+10V Bus:	+0.000	+0.0767	0.000	Volts
11	GASFET Bias I:	+0.000	+0.000026	0.000	Amps
12	Ground REF:	+0.000	+0.0100	0.000	Volts
13	+Z Array V:	+0.000	+0.1023	0.000	Volts
14	Rx Temp:	+100.01	-0.5980	0.000	Deg. C
15	+X (RX) Temp:	+100.01	-0.5980	0.000	Deg. C
16	Bat 1 V:	+1.8292	-0.0037196	0.000	Volts
17	Bat 2 V:	+1.8202	-0.0036943	0.000	Volts
18	Bat 3 V:	+1.8050	-0.0036721	0.000	Volts
19	Bat 4 V:	+1.8576	-0.0038979	0.000	Volts
1A	Bat 5 V:	+1.8095	-0.0037439	0.000	Volts
1B	Bat 6 V:	+1.8979	-0.0041754	0.000	Volts
1C	Bat 7 V:	+1.8246	-0.0038126	0.000	Volts
1D	Bat 8 V:	+1.7486	-0.0030475	0.000	Volts
1E	Array V:	+7.800	+0.06790	0.000	Volts
1F	+5V Bus:	+1.838	+0.0312	0.000	Volts
20	+8.5V Bus:	+5.793	+0.0184	0.000	Volts
21	+10V Bus:	+7.650	+0.0250	0.000	Volts
22	BCR Set Point:	-6.1963	+1.1277	0.000	Counts
23	BCR Load Cur:	-0.0405	+0.00620	0.000	Amps
24	+8.5V Bus Cur:	+0.00384	+0.000830	0.000	Amps
25	+5V Bus Cur:	-0.00763	+0.00394	0.000	Amps
26	-X Array Cur:	-0.00140	+0.00210	0.000	Amps
27	+X Array Cur:	+0.00946	+0.00226	0.000	Amps
28	-Y Array Cur:	-0.01018	+0.00224	0.000	Amps
29	+Y Array Cur:	-0.01168	+0.00239	0.000	Amps
2A	-Z Array Cur:	-0.01516	+0.00237	0.000	Amps
2B	+Z Array Cur:	-0.02111	+0.00239	0.000	Amps
2C	Ext Power Cur:	-0.02000	+0.00250	0.000	Amps
2D	BCR Input Cur:	-0.02189	+0.00332	0.000	Amps
2E	BCR Output Cur:	-0.03019	+0.00327	0.000	Amps
2F	Bat 1 Temp:	+100.01	-0.5980	0.000	Deg. C
30	Bat 2 Temp:	+100.01	-0.5980	0.000	Deg. C
31	Baseplate Temp:	+100.01	-0.5980	0.000	Deg. C
32	PSK TX RF Out:	+0.2104	-0.01203	+0.0001786	Watts
33	RC PSK TX Out:	+0.0340	-0.00969	+0.0002198	Watts
34	PSK TX HPA Temp	+100.01	-0.5980	0.000	Deg. C
35	+Y Array Temp:	+100.01	-0.5980	0.000	Deg. C
36	RC PSK HPA Temp	+100.01	-0.5980	0.000	Deg. C
37	RC PSK BP Temp:	+100.01	-0.5980	0.000	Deg. C
38	+Z Array Temp:	+0.0000	+1.0000	0.000	Counts

ADC Equations: V = 0.01016 N - 0.05080
N = 98.43 V +5.000

Spacecraft: DOVE-1:
Date: 1/7/90

Equations are in the form: Y = A*N^2 + B*N + C

where: N = Telemetry Count (00 - FF)
A, B, C = Equation Coefficients
Y = Result (In Specified Units)

HEX	Descripion:	C:	B:	A:	Units:
		cccccccccc	bbbbbbbbbb	aaaaaaaaaa	uuuuu
0	Rx E/F Audio(W)	+0.000	+0.0246	0.000	V(p-p)
1	Rx E/F Audio(N)	+0.000	+0.0246	0.000	V(p-p)
2	Mixer Bias V:	+0.000	+0.0102	0.000	Volts
3	Osc. Bisd V:	+0.000	+0.0102	0.000	Volts
4	Rx A Audio (W):	+0.000	+0.0246	0.000	V(p-p)
5	Rx A Audio (N):	+0.000	+0.0246	0.000	V(p-p)
6	Rx A DISC:	+10.427	-0.09274	0.000	kHz
7	Rx A S meter:	+0.000	+1.000	0.000	Counts
8	Rx E/F DISC:	+9.6234	-0.09911	0.000	kHz
9	Rx E/F S meter:	+0.000	+1.000	0.000	Counts
A	+5 Volt Bus:	+0.000	+0.0305	0.000	Volts
B	+5V Rx Current:	+0.000	+0.000100	0.000	Amps
C	+2.5V VREF:	+0.000	+0.0108	0.000	Volts
D	8.5V BUS:	+0.000	+0.0391	0.000	Volts
E	IR Detector:	+0.000	+1.000	0.000	Counts
F	LO Monitor I:	+0.000	+0.000037	0.000	Amps
10	+10V Bus:	+0.000	+0.05075	0.000	Volts
11	GASFET Bias I:	+0.000	+0.000026	0.000	Amps
12	Ground REF:	+0.000	+0.0100	0.000	Volts
13	+Z Array V:	+0.000	+0.1023	0.000	Volts
14	Rx Temp:	+101.05	-0.6051	0.000	Deg. C
15	+X (RX) temp:	+101.05	-0.6051	0.000	Deg. C
16	Bat 1 V:	+1.7932	-0.0034084	0.000	Volts
17	Bat 2 V:	+1.7978	-0.0035316	0.000	Volts
18	Bat 3 V:	+1.8046	-0.0035723	0.000	Volts
19	Bat 4 V:	+1.7782	-0.0034590	0.000	Volts
1A	Bat 5 V:	+1.8410	-0.0038355	0.000	Volts
1B	Bat 6 V:	+1.8381	-0.0038450	0.000	Volts
1C	Bat 7 V:	+1.8568	-0.0037757	0.000	Volts
1D	Bat 8 V:	+1.7868	-0.0034068	0.000	Volts
1E	Array V:	+7.205	+0.07200	0.000	Volts
1F	+5V Bus:	+1.932	+0.0312	0.000	Volts
20	+8.5V Bus:	+5.265	+0.0173	0.000	Volts
21	+10V Bus:	+7.469	+0.021765	0.000	Volts
22	BCR Set Point:	-8.762	+1.1590	0.000	Counts
23	BCR Load Cur:	-0.0871	+0.00698	0.000	Amps
24	+8.5V Bus Cur:	-0.00920	+0.001899	0.000	Amps
25	+5V Bus Cur:	+0.00502	+0.00431	0.000	Amps
26	-X Array Cur:	-0.01075	+0.00215	0.000	Amps
27	+X Array Cur:	-0.01349	+0.00270	0.000	Amps
28	-Y Array Cur:	-0.01196	+0.00239	0.000	Amps
29	+Y Array Cur:	-0.01141	+0.00228	0.000	Amps
2A	-Z Array Cur:	-0.01653	+0.00245	0.000	Amps
2B	+Z Array Cur:	-0.01137	+0.00228	0.000	Amps
2C	Ext Power Cur:	-0.02000	+0.00250	0.000	Amps
2D	BCR Input Cur:	+0.06122	+0.00317	0.000	Amps
2E	BCR Output Cur:	-0.01724	+0.00345	0.000	Amps
2F	Bat 1 Temp:	+101.05	-0.6051	0.000	Deg. C
30	Bat 2 Temp:	+101.05	-0.6051	0.000	Deg. C
31	Baseplt Temp:	+101.05	-0.6051	0.000	Deg. C
32	FM TX#1 RF OUT:	+0.0256	-0.000884	+0.0000836	Watts
33	FM TX#2 RF OUT:	-0.0027	+0.001257	+0.0000730	Watts
34	PSK TX HPA Temp	+101.05	-0.6051	0.000	Deg. C
35	+Y Array Temp:	+101.05	-0.6051	0.000	Deg. C
36	RC PSK HPA Temp	+101.05	-0.6051	0.000	Deg. C
37	RC PSK BP Temp:	+101.05	-0.6051	0.000	Deg. C
38	+Z Array Temp:	+101.05	-0.6051	0.000	Deg. C
3A	S band TX Out:	-0.0451	+0.00403	0.000	Watts
39	S band HPA Temp	+101.05	-0.6051	0.000	Deg. C

ADC Equations: V = 0.01028 N - 0.05138
N = 97.31 V +5.000

BCR voltage sensory circuits. All transmitters were exercised with the single exception of the AMSAT-LU CW beacon. They are all working beautifully producing 4 Watts at wonderful efficiencies and with power agility that will make this mission a success. We did not have the PN sequence generator which will turn on the LUSAT beacon, so we were unable to exercise this module. However, it performed like gangbusters in thermal vacuum test and after the shake test, so it is probably still in good shape. All power modules are now working nicely and all the myriad of sensory circuits have been debugged by NK6K, Doug Loughmiller, KO5I, W3GEY, and myself.

The thermal analysis for these birds having been recently completed by Dick Jansson, WD4FAB, the necessary thermal control tapes were partially applied by Chuck Stout and Greg Hines, WDØM. Jan checked out the solar panels in the circuit by placing them in the sun outside the lab and making careful measurements. They performed as expected. These are special back reflecting silicon cells which recapture photons that make it through the silicon the first time. This part of the process is obvious. Where it gets tricky is how does one build up this matrix into a stable, usable configuration for space. Solarex, the manufacturer, developed the system and it survived thermal testing, shake tests, and all our handling to produce very nice solar panels. We will easily meet our power budget requirements.

Chris Williams came from CAST and brought the latest and greatest WEBER module experimental software. After a little work with Harold, the software was loaded. The spacecraft was commanded to take a series of pictures. The pictures then began downlinking and was copied by the command station in the lab. We anxiously huddled around as Harold brought up the display program he has been working on, and a fantastic picture of Rocky Mountain peak, Arapahoe, with trees clearly visible, buildings and trees in the foreground, coaxial cables on the table next

to the door, and more were clearly visible. This was the first proof we had the experiment had survived thermal vacuum and shake tests. Needless to say, the jumps for joy from somewhere in Utah were heard in Boulder.

I will be spending several hours in the next couple of weeks getting the DOVE module ready for final testing with a completely new set of phonemes that were used to test the functionality of the hardware. Unfortunately, the Ariane people have given us very little time to work with our spacecraft after we power them up. There will be no time for loading large files of speech into the main memory. A small set of phonemes is all that we will be allowed to fly because of the constraint of time in Kourou. Junior, PY2BJO, the sponsor of DOVE, and the builders (N4HY, KB2CST, and KA2MOV) are of course disappointed that no more than a small amount can be uploaded before launch. Soon after launch however, we will begin uploading large files of speech and phonemes as fast as the short passes will allow.

Telemetry status and wrap-up·

Doug and I gathered gobs of telemetry, and Harold and I have begun writing a display program for all the telemetry. We had the first version working during the thermal vacuum tests in September. I have many of the telemetry equations that Jan has derived for each spacecraft. After we confirm that the values are still correct with the changes made to the power module sensor circuitry, we will be letting go of a useful version of this and will be publishing the telemetry equations so you can roll your own. Doug was a great help to me while doing some of the incredibly tedious modification work to both CPU's and power modules. Jeff Zerr was a great help as always doing most of the mechanical work during the week, and Harold and Skip worked all during the week in California and were available at all the wrong hours on the telephone for consultations making up a very productive week for me. My fellow satellite enthusiasts, I can finally say from the heart that we have four spacecraft in the Boulder labs. Much remains for Harold, Skip, and I to do in the way of software before launch but we are plugging away at it. I am sure that if I have forgotten something, someone will remind me. — *Bob, N4HY*

Nov 30, 1989 Situation Report

The team leaves on December 1 from Colorado with the satellites. Various other team members will travel from around the world to the launch site in French Guiana on the northern coast of South America.

The latest official launch date from Arianespace is now January 9, 1990 at 0140 UTC plus or minus a few minutes. Four MicroSats and two UoSAT birds will ride on a small satellite shelf designed for missions such as ours under the SPOT-2 satellite. The launch window is determined by need for the primary mission, Spot-2, to be in a given sun-synchronous orbit. This will bring Spot-2, the MicroSats, and the UoSAT's overhead at about the same time each morning and evening.

This past week saw the finishing touches put on the initial flight software load. Harold Price, NK6K, and Bob McGwier, N4HY, worked on finishing off the software. NK6K finished the kernel, initial AX.25 software, the software loader, and the memory wash (to correct for radiation induced errors). N4HY finished the initial control code for each satellite.

On Thanksgiving day, N4HY, Jan King, W3GEY, Jeff Zerr, and Greg Hines, WDØM began making the final telemetry calibrations, and final testing of the battery charge regulation control loop, and the transmitter power control algorithm. All four MicroSats had their algorithms extensively tested and the spacecraft were left operational for days. The algorithms were run under simulation by simulating the solar arrays with a current limited power supply, various timers to simulate eclipses, and beginning from various states of battery charge. In every case, the overdamped control loops behaved perfectly. The hardware was extensively exercised under command code using AX.25 packets from a normal TNC. Various transmitters, experiments, etc. were tested. NK6K's memory wash routines and software loaders were repeatedly used without fault.

At last, an end to end test, from ground station to algorithm controlling the DOVE voice experiments, was performed. The Motorola 68HC11 in the DOVE module acting as a very smart UART chip, was sent a program from the spacecraft IHU and it then ran the digital to analog converter (DAC). This provided an end to end test on both hardware and software that until this test had been run, had never been exercised as a system. It was a working testimonial to the modular approach taken in the spacecraft design. On Tuesday, a program to exercise the digitalker, the VOTRAX SC-02 chip, was loaded and speech was produced from the DOVE spacecraft for the first time. The entire DOVE speech hardware has now been shown to produce the correct signals and signal levels. This will promise to be an extremely loud signal with a 4 Watt transmitter and 4 kHz deviation.

CAST had WEBERSAT the week preceding these tests. They tested all the experiments on their 'attic' which sits on top of a normal MicroSat configuration. During this period and the earlier testing that occurred in Boulder, several pictures were taken and downloaded via the packet channel. The camera produces very good pictures and the mechanical iris functions well. The extensive environmental testing that has gone appears to have done no damage to the iris. This promises to be an extremely popular bird and satellite to watch (pun intended). Other than a minor

Chronology of Events For The Launch of V-35B

Event	Mission Elapse Time (HH:MM:SS.SS)
Open 1st Stage Engine Valves	00:00:00.00
Lift-Off & Clear Gantry	00:00:04.00
Initiate Launcher Roll Maneuver	00:00:14.00
Initiate Launcher Pitch Maneuver	00:00:14.00
Launcher Reaches Speed of Sound	00:01:19.00
Launcher Experiences Max. Dyn. Pressure	00:01:34.00
1st Stage Engine Fuel Depleted	00:02:32.60
1st Stage SEPARATION	00:02:37.50
2nd Stage Ignition	00:02:37.70
Begin 2nd Stage Guidance	00:02:47.60
Begin 2nd Stage Roll Maneuver	00:02:47.60
Finish 2nd Stage Roll Maneuver	00:03:08.00
Separation Of Launcher Fairing	00:03:48.80
2nd Stage Fuel Depleted	00:04:42.00
2nd Stage SEPARATION	00:04:46.90
Begin 3rd Stage Guidance	00:04:47.90
Ignition of 3rd Stage Engine	00:04:50.50
Begin Orientation Maneuver for 3rd Stage	00:04:53.90
Acquisition of Bermuda Tracking Station	00:07:50.00
Acquisition of Wallops Island Tracking Stn.	00:11:20.00
End of Tracking for Kourou Space Center	00:15:40.00
Separation of SPOT-2 Satellite	00:17:04.00
Perform First Reorientation of 3rd Stage	00:17:08.00
End First Reorientation Maneuver	00:17:29.00
Perform Second Reorientation Maneuver	00:20:04.00
SEPARATION OF UOSAT D/E	00:20:04.00
Finish Second 3rd State Reorientation	00:20:08.00

Information about MicroSat telemetry decoding programs appears on page 18.

accident requiring several hours of work to repair, these tests went off without a hitch.

Finally after several days of running the control algorithms on the spacecraft, after all spacecraft passed all their memory tests okaying a total of 32 Megabytes of storage, the control algorithms functioned appropriately, telemetry calibrated, and AX.25 being used to command the spacecraft, W3GEY, the project manager proclaimed that we had four live spacecraft, ready to begin "on orbit" operations.

There will be an extensive engineering test phase immediately after launch. We will be fine tuning the control algorithms in space, finish off the BBS code, hundreds of thousands of kilobytes of digitized voice must be uploaded to DOVE, and hours of upload of camera software to WEBERSAT must be accomplished. NK6K and N4HY will be spending numerous hours each day at their QTH's and at the TRW radio club in Redondo Beach, Ca. getting the spacecraft fully loaded with software and taking the pulse of the spacecraft. In addition to the MicroSat's, NK6K and Skip Hansen, WB6YMH, (who has written the low level I/O drivers for the MicroSat's) have extensive software responsibility for UoSAT. This promises to be a busy time for all. — *Bob, N4HY*

January 8, 1990 SPOT-2 Problem; Further Launch Delay

Today it was announced by Arianespace officials that the V35 launch will be delayed further due to problems with the SPOT-2 satellite. The problem with SPOT-2 is due to a magnetic tape recorder failure. The plan is to remove the fairing from the launcher and replace the tape recorder on SPOT-2. This operation will start today at 5:00 P.M. Tomorrow we will set up the battery chargers in the S3B building as they were before moving to the launcher. The plan right now is to not remove any MicroSat/UoSAT satellites from the ASAP. Provisions are being made to protect all ASAP spacecraft during the repair of SPOT-2. The launch is now planned for January 26, 1990 at 01:35 UTC. This evening myself (WDØHHU) and Max (G7DQE) will be attending a meeting with Arianespace officials to discuss all the details about the battery charging and the SPOT-2 repairs. — *Dave, WDØHHU*

January 9, 1990 Kourou Reporting

The composite is now back at building S3B and they will be breaking apart the fairing later today around 2:00 P.M. We will be able to start battery charging around 4:00 P.M. We know that puts the time off at about 23 hours but there is no way around this problem. We will charge for 14 hours. The new tape recorder for SPOT-2 will be flown in via Frankfurt and will arrive tomorrow at the Space Center. SPOT people are still assessing how long it will take them. The optimistic outlook is that we could be ready for a launch on January 24, 1990 at 01:35 UTC. This will give them many opportunities to phase SPOT-2 correctly with SPOT-1. We won't know exactly what the launch date will be until Thursday. At that time SPOT will know how difficult it will be to replace the tape recorder. If they have to remove an antenna, then it will take two extra days. We will replace the solar array covers on the MicroSats and UoSATs and will coordinate the steps to protect the ASAP satellites from falling objects. — *Dave, WDØHHU, Max, G7DQE, Junior, PY2BJO*

January 10, 1990 Kourou Reporting

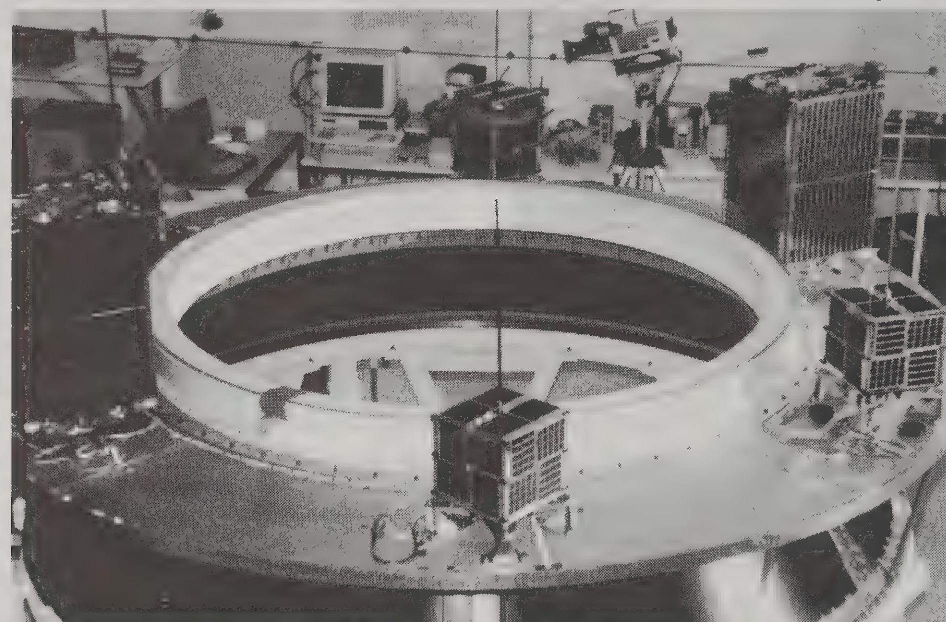
Last night we replaced the solar panels on all the MicroSats that could potentially be damaged by falling objects. UoSAT-D, PACSAT, and WEBER are in potential drop-zones. Only DOVE is in the clear.

This magnetic tape recorder replacement operation is going to be very difficult for the SPOT people. Arianespace and SPOT officials have assured me that all tools will be tethered to the technicians. There is a bubble plastic drop-cloth all around UoSAT-D and AMSAT-NA. I can't get the S-Band antenna off AMSAT-NA. I will modify the top protection panel and we will put a plastic tube around the S-band antenna. That is the best I can do. We will be charging the batteries about 23 hours today. Once again we apologize for not being on 15 Meters at 00:00 UTC. We were not finished until 8:40 Kourou time and Junior, PY2BJO, and Max, G7DQE had to go get something to eat after this 18-hour day with no lunch. Junior came back around 10:30 P.M. and I took off to get a few hours of sleep.

The launch story continues in the next issue of The AMSAT Journal. *For now, it's . . . Not The End, BUT, The Beginning!*

References

[1]The First Flock of Microsats, Tom Clark, W3IWI, Jan King, W3GEY, Bob McGwier, N4HY and the AMSAT team, The AMSAT Journal, Volume 12 Number 1, May 1989.



MicroSats and UoSATs on the ASAP (Launch Vehicle Platform) in the clean room, S3A, CSG, Kourou, French Guiana.

The President's Editorial

(Continued from page 22)

with advertising, the income we derive from this source does not totally offset our production costs. As a result, we are limited in the total page count that we can afford to produce on a regular basis. Likewise, the format in which we produce the publication has to be cost effective.

After evaluating all of the factors involved in the production of a quality publication and after considering the many different questions which must be answered in regards to the application of AMSAT's resources to this mission, one must stop and reflect upon the objectives and needs that the publication are to fill.

Our publication represents only one element of our information distribution system. AMSAT volunteers spend a very considerable amount of time each week in making information available via various media. For instance, material is distributed by the AMSAT News Service for use by the AMSAT nets and the packet radio BBS services around the globe. A number of dial-up BBSs post the AMSAT News Service material as well. In addition, W1AW transmits pertinent information during their daily bulletins. As a result, regularly updated information is available from a number of different sources. With the advent of six new OSCAR satellites it is likely that even more distribution channels will be utilized for this purpose in the near future.

While the News Service material fulfills one set of needs, clearly the publication must fill yet others. For example, our publication should serve as the means by which we document our very unique contributions to the Amateur Radio hobby. It must serve as the distribution channel for information that cannot be exchanged via direct Amateur Radio communications such as the availability of new products, solicitation of financial contributions and the like. Also, it must serve as the forum for tutorial material and in-depth articles too lengthy or inappropriate for on-the-air distribution.

Nineteen eighty-nine was a transition year for AMSAT's publications. At the request of the AMSAT Board of Directors, Joe Kasser, G3ZCZ, picked up where he had left off in the summer of 1981, and resumed the Editorship of AMSAT's publication. During 1989 he published four *Journals* which received rave reviews. In order to give Joe "a little breathing room" while he built the *Journal* up, at my direction, we continued to publish *ASR* but at a reduced production cycle of once a month. This was implemented only as an interim measure to allow Joe to reestablish his routine and once again grow comfortable with the process of producing the Journal. During this period of time I asked John Champa, K8OCL, to take on the task of producing the monthly *ASR*. John did so in addition to the other tasks he was fulfilling for our organization. I greatly appreciate the fine job John did for us during this period of time. I owe John a debt of gratitude and saying "Thank You" hardly seems enough.

As we enter into 1990, for the various reasons mentioned above, we will be making a number of changes in the area of AMSAT publications. Effective with *Amateur Satellite Report* Number 193 dated January 18, 1990 we are suspending the publication of *ASR*. Now that Joe has hit his full stride in producing the *Journal* we will be funnelling our full resources into this single publication. In 1990 we expect to publish the *Journal* at least six times. Our goal is eight, but that will depend on you, the author/reader. As such, and for the reasons I explained above, we simply cannot support more than one publication. In this issue, the *Journal* picks up the mantle of its subtitle "the AMSAT Newsletter" and contains both technical material and news items. The hottest news this issue being of course the MicroSat Launch Story. While it may be sad to think that *ASR* will no longer appear, it has served its purpose and has reached the end of its mission. I am sure that you will join me in helping G3ZCZ in any way possible to make *The AMSAT Journal* the best publication that it can possibly be. Joe will need submissions from many of us to make the *Journal* as balanced and as complete as possible. He cannot generate all of the material himself. I know he would welcome your input.

These are truly dynamic times for AMSAT and the Amateur satellite program. It is my earnest hope that the enthusiasm, excitement and pride we all feel in being a part of this worthwhile program can adequately be depicted in the pages of *The AMSAT Journal*. With the unified efforts of a broad base of capable volunteers working in accord with G3ZCZ I know we can't miss!

DX'ing the OSCAR's

By John Fail KL7GRF/W6

6170 Downey Avenue
Long Beach, CA 90805 U.S.A.

Congratulations to: Alan, VE6LQ, on working his 100th country via AMSAT-OSCAR-13; Jussi, OH5LK, and Hardy, DC8TS, for working country Number 130 on the satellites; John, K2JNS, for receiving notification of his earning the much coveted Satellite DXCC award from the ARRL.

Several stations are now approaching the 100 DXCC countries worked level on AMSAT-OSCAR-13. If anyone has earned a major Satellite award that I have not acknowledged please let me know (145.890 MHz). I received (January 20, 1990) a complete list of Satellite DXCC awards issued by ARRL and will publish it soon.

DX Notes

Apparently several of us were "taken for a ride" by XT1FF. The listed QSL manager (F6IGM) has returned all cards. He has no idea who XT1FF is. Also be wary of a station who occasionally comes on as 6W1NQ and is a "slim" (a "slim" is an illegal operation - someone using another stations call). I have corresponded with the real 6W1NQ. He has no satellite equipment. Note that 6W1QA/QB is real.

Rare U.S. states heard: Mississippi, NC5Y, Delaware, K3JL and KD3OJ.

December 16, 1989 was quite exciting on AMSAT-OSCAR-13 with 9Q5EE, ZS3DM, HH2RP and Z21HJ/R all appearing within minutes of each other on Mode B. These stations indicate they will be very active in the future.

Hardy, DC8TS, reports 7X2AJ may be back on the birds very soon. FH8CL should be back in Mayotte by the time you read this. I finally received a card from YI1BGD on Dec 20. After 6 cards sent directly to YI1BGD, Klaus, DD3NJ, said to try a card to DF3NZ. The reply came in three weeks. YI1BGD showed up on AMSAT-OSCAR-13 on December 21, and continues to be very active.

Tony, KP4EKG, says that all QSL cards for P4/KP4EKG were mailed as of 12/31/89. Tony is planning a short-notice expedition to HI (Dominican Republic) in late January or early February which should have been completed by the time you read this.

Has anyone received a card from RA2FAG? Several DX'ers are having trouble getting this card. 9M2ZZ appeared on AMSAT-OSCAR-13 on Jan. 6 operating from 9M2CS. Kevin says he plans to obtain OSCAR equipment of his own. Z21HJ says that "green stamps" should not be sent with QSL's. It's a problem with U.S. currency in Zimbabwe. Do include at least one IRC, however. Some of the QSL cards sent out by Z21HJ indicated "VIA OSCAR-13 MODE B" but incorrectly were marked as 28 MHz in addition to the "VIA OSCAR-13 MODE". I spoke with Don Search, W3AZD, the person in charge of DXCC at the ARRL who indicated that this is not a problem and the card will be credited for a Satellite DXCC in spite of the 28 MHz marking. Do remember the card must indicate a Satellite contact or it is not valid. Several stations are reporting receipt of a QSL card from Mario, VP8ALJ, in the Falkland Islands. I had given up hope on this one, but maybe we will all finally get cards from VP8ALJ.

Chip, K7JA, operated on AMSAT-OSCAR-13 from K7SS/PTI January 14th for several hours. QSL to K7SS. The "PTI" stands for "(P)uyallap (T)ribe of (I)ndians". This Indian Nation, which is an Indian Reservation in Western Washington State has applied to the ARRL DXCC Committee for separate country status under existing DXCC rules. Apparently they have submitted some impressive documents to support their request for separate country status. I have no idea if separate country status will be granted nor do I have any idea if the contacts made on January 14 would count towards DXCC credit for the country if country status is indeed granted at a later date.

Bouvet Island

By the time you read this the anticipated Bouvet Island DXpedition will have been completed. As most of you know by now the expedition was postponed for an undetermined period in early January. The vessel that was to transport the crew to Bouvet suddenly became unavailable to make the trip to the Island and is not available to reschedule the trip before the Antarctic winter. The weather in the Antarctic is of course very unpredictable and the expedition had to be conducted in a very narrow time slot which now cannot be met. The group that was to make the expedition has some other plans in the works that will include Satellite operation. I expect that the plans may come together very quickly and on short notice. Keep an ear on 145.890 MHz for late breaking developments. I do full well expect that an expedition to Bouvet will be accomplished, but not in the immediate future.

Juan Fernandez

I had hoped to have the callsign (XQØZ?? or CEØZ??) that will be used from the Island in hand before publishing this information but as of this date (01/23/90) the callsign has not been assigned by the Chilean Government. It is expected that the callsign will be issued any day now.

A problem has arisen with my participation in the expedition. A business commitment has precluded my leaving California during the time of the expedition. My discussions with Pedro, CE3BFZ, indicate that the expedition will still take place. The expedition may occur as much as a month earlier (in March 1990) than previously indicated (April 1990). Check on 145.890 MHz for late breaking developments on this operation. There will be a change in QSL information for OSCAR contacts to be announced later (check on 145.890 MHz for late information). The QSL manager for 6 Meter and hf contacts is Pedro Barroso, CE3BFZ, Box 13312, Santiago 1, Chile

Upcoming OSCAR DXpeditions

Possible operation from CO (Cuba) by VE1KG during the spring of 1990. There are several possibilities for expeditions in the near future but it is premature to speculate on them at this time. Some of the possible operations have very "short fuses", keep an ear on 145.890 MHz for late information.

QSL Bureaus

I intended to include QSL bureau information as promised in my previous column in *Amateur Satellite Report* No. 193, but, with apologies, I will include it soon.

Closing

I am looking for pictures of DX stations to include in my articles. If you have information about new DX stations on the birds, upcoming OSCAR DXpeditions or general DX info send it or look for me on Mode B (145.890 MHz) or Mode J (435.960 MHz). Late breaking DX information is often available on Mode B, 145.890 MHz.

SATELLITE ORBITAL ELEMENTS

By Eric Rosenberg WA6YBT

c/o AMSAT

Starting with this issue of the Journal, we will be presenting the Keplerian Elements for amateur satellites in the 2-line NASA format. The reason for this is to conserve space in the Journal and present all the elements on a single page.

NASA 2-line elements as shown below are available electronically, and can be read directly into QuikTrak v4.0, and Instant Track v1.0 — both available from the AMSAT office .

Should you want to see a specific satellites set of elements in long form that you have been used to using, you can either translate them manually using the key below, or run the 2-line element set through a program written by Bob McGwier, N4HY, called ELETRANS.EXE which is available on the AMSAT (DRIG) BBS and on CompuServe.

The NASA 2-line element sets themselves are available from a variety of sources, including AMSAT (DRIG) BBS, CompuServe, The Celestial BBS in Fairborn, Ohio and the Internet.

Data for each satellite consists of three lines in a fixed format shown in Table 1, using AMSAT-OSCAR-13 as an example.

Line 1 is the satellite's name

Lines 2 and 3 are the standard Two-Line Orbital Element Set Format identical to that used by NASA and NORAD. The format description for Line 2 is:

Column	**Description**
01-01	Line Number of Element Data
03-07	Satellite Catalog Number
10-11	* International Designator (Last two digits of launch year)
12-14	* International Designator (Launch number of the year)
15-17	* International Designator (Piece of launch)
19-20	Last two digits of epoch year
21-32	Epoch (Julian Day and fractional portion of the day)
34-43	Drag or Decay Rate
45-52	* Second Time Derivative of Mean Motion (Blank if N/A)
54-61	* BSTAR drag term if GP4 general perturbation theory was used. Otherwise, radiation pressure coefficient.
63-63	* Ephemeris type
65-68	Element set number
69-69	* Check Sum (Modulo 10) (Letters, blanks, periods = 0; minus sign = 1; plus sign = 2)

(* generally not necessary or applicable to most AMSAT software. Instant Track uses the check sum to determine if the element set is correctly formatted)

The pertinent items in line 2 translate as:

Catalog ID:	19216
Epoch Year:	90
Epoch Day:	21.40340404
Drag:	-0.00000075 revs/day/day
Element set:	70

The format description for Line 3 is:

Column	Description
01-01	Line Number of Element Data
03-07	Satellite Catalog Number
09-16	Inclination in degrees
18-25	Right Ascension of the Ascending Node in degrees
27-33	Eccentricity (a leading decimal point is assumed)
35-42	Argument of Perigee in degrees
44-51	Mean Anomaly in degrees
53-63	Mean Motion in revolutions (orbits) per day
64-68	Orbit number at the epoch given above
69-69	Check Sum (Modulo 10)

The pertinent items in line 3 translate as:

Catalog ID:	19216
Inclination:	57.1171 degrees
RA of Node:	172.3126 degrees
Eccentricity:	0.6876271
Argument Perigee:	219.5193 degrees
Mean Anomaly:	61.5621 degrees
Mean Motion:	2.09701111 revs/day
Orbit #:	1232

This is what the entire AMSAT-OSCAR-13 two-line element set translates to:

Satellite:	AO-13
Catalog ID:	19216
Element set:	70
Epoch Year:	90
Epoch Day:	21.40340404
Drag:	-0.00000075 revs/day^2
Inclination:	57.1171 degrees
RA of Node:	172.3126 degrees
Eccentricity:	0.6876271
Argument Perigee:	219.5193 degrees
Mean Anomaly:	61.5621 degrees

Table 1: Sample Element Set for AMSAT-OSCAR 13

```
AO-13
1 19216U 88 51  B 90 21.40340404 -.00000075  00000-0  99999-4 0   704
2 19216  57.1171 172.3126 6876271 219.5193  61.5621  2.09701111 12323
```

Telephone numbers: DRIG (AMSAT): 214-394-7438
Celestial BBS: 513-427-0674

ORBIT ELEMENTS

```
AO-10
1 14129U 83 58  B 90 49.80793411  .00000000  00000-0  00000 0 0  4563
2 14129  25.9253 218.0969 5995939 119.7301 312.5438  2.05881409 22299
UO-11
1 14781U 84 21  B 90 60.18781917  .00002418  00000-0  46018-3 0  6212
2 14781  97.9647 116.2327 0012630 224.1641 135.8969 14.64947016320153
AO-13
1 19216U 88 51  B 90 64.31515086 -.00000152  00000-0  99999-4 0   785
2 19216  57.0498 165.9392 6905543 222.3916  56.3646  2.09702956 13224
UO-14
1 20437U 90  5  B 90 64.23732462  .00000611  00000-0  26007-3 0   254
2 20437  98.7050 140.6255 0012158  97.3447 262.9129 14.28507740  6028
UO-15
1 20438U 90  5  C 90 62.28232745  .00000660  00000-0  28090-3 0   233
2 20438  98.7075 138.6738 0011025 100.7846 259.4587 14.28283540  5749
AO-16
1 20439U 90  5  D 90 64.16465829  .00000777  00000-0  32546-3 0   256
2 20439  98.7168 140.5878 0012185  95.8666 264.3919 14.28603915  6019
DO-17
1 20440U 90  5  E 90 64.30377124  .00000865  00000-0  36020-3 0   163
2 20440  98.7174 140.7307 0{0Z1i2360  95.4210 264.8386 14.28639385  6038
WO-18
1 20441U 90  5  F 90 61.28907691  .00000940  00000-0  38882-3 0   146
2 20441  98.7104 137.7200 0012992 105.4532 254.8093 14.28745727  5604
LO-19
1 20442U 90  5  G 90 62.26761139  .00000715  00000-0  29924-3 0   216
2 20442  98.7162 138.7040 0013156 102.2705 257.9956 14.28813385  5745
FO-20
1 20480U 90 13  C 90 64.07294708  .00000108  00000-0  29339-3 0   161
2 20480  99.0543 130.1820 0540794 284.3909  69.7805 12.83117019  3398
RS-10/11
1 18129U 87 54  A 90 49.95895744  .00000409  00000-0  43844-3 0   415
2 18129  82.9234  55.8728 0013442  87.4289 272.8445 13.72060837133239
```

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